Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

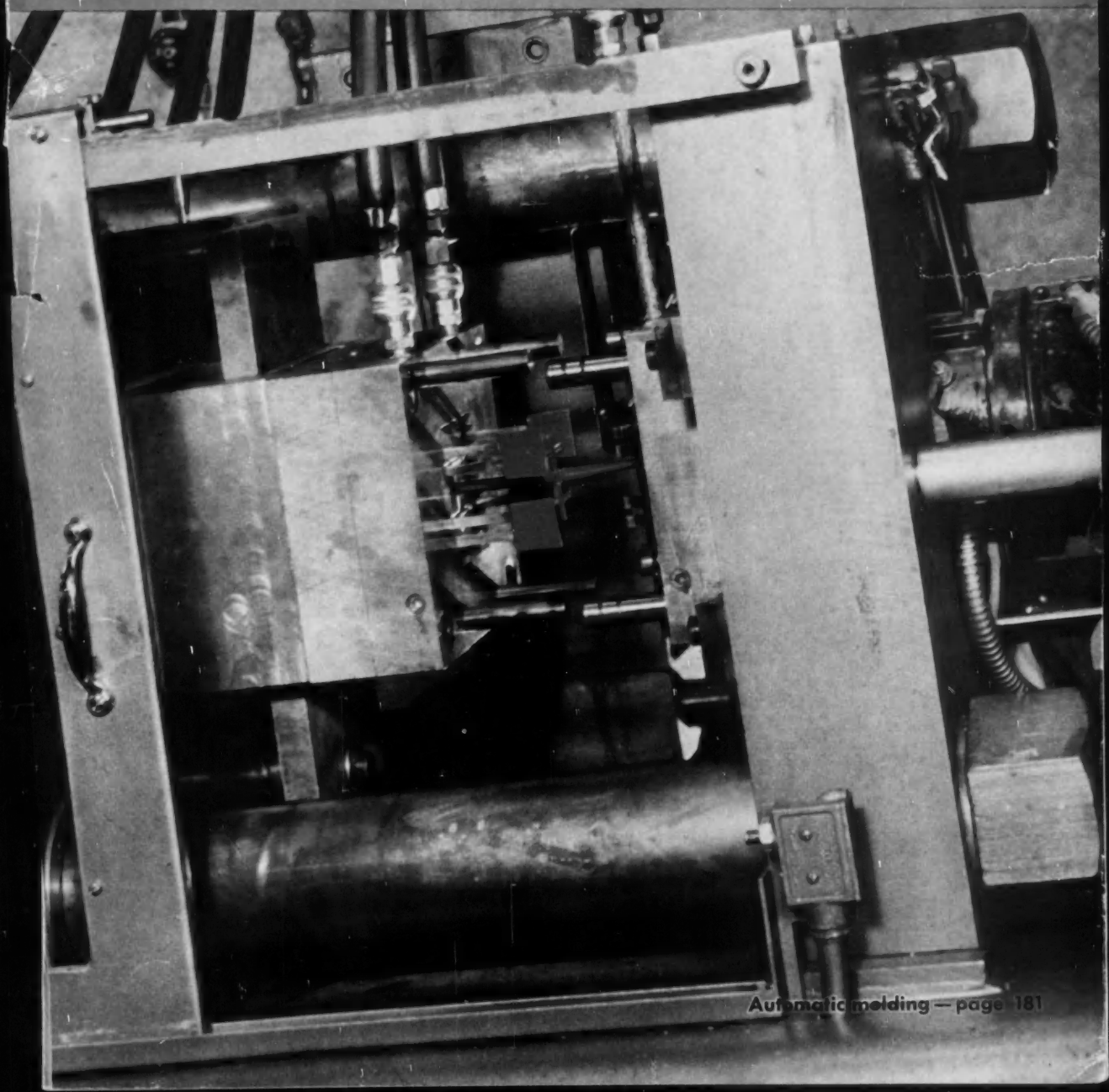
JUNE 1956

Corrosion Resistance of Titanium

High Speed Photography

Composite Sections

Plastic Springs

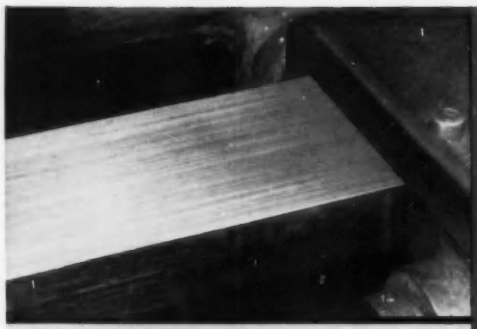


Automatic molding — page 181

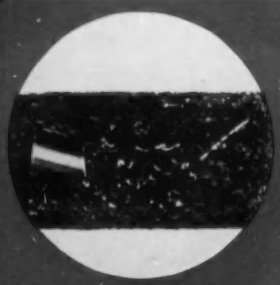
NEW, BETTER

C/R way wiper

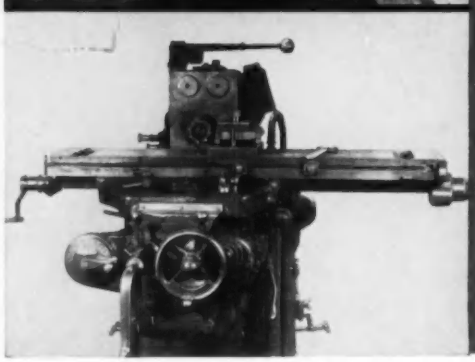
guards the life, cuts downtime, saves costly maintenance on machine tool ways



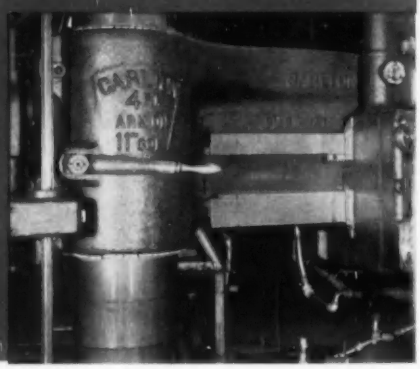
This close-up photograph shows harmful chips and abrasives trapped in a fibrous wiper that permitted scoring of the lathe way shown at left.



The extent of scoring and abrasion caused by chips trapped under the carriage is clearly shown in this photograph of a lathe way.



C/R Way Wipers are quickly, easily installed on this milling machine, as well as on shapers, grinders, planers, and gear cutters.



The clean, score-free wiping action of C/R Way Wipers is evident again in this partial view of a radial drill. Note how close, accurate lip contact on the column is achieved, even though the wiper is mounted on uneven surfaces.

How many hundreds of dollars are scoring and abrasion of machine tool ways costing your shop each year . . . dollars that could easily be saved? C/R Sirvene (synthetic rubber) Way Wipers make it unnecessary to tolerate this expensive damage. They are designed and precision molded for an extremely accurate fit. They will *not* trap harmful materials . . . will not mark or smudge ways. They will wipe ways clean of dirt, chips, fine abrasives . . . even water emulsions . . . yet leave a thin, protective oil film. C/R Sirvene Way Wipers will fit flat ways, side rails, angles, columns and hydraulic rams . . . and are easily installed. They will save you many times their cost. Please write for illustrated brochure that gives complete details.

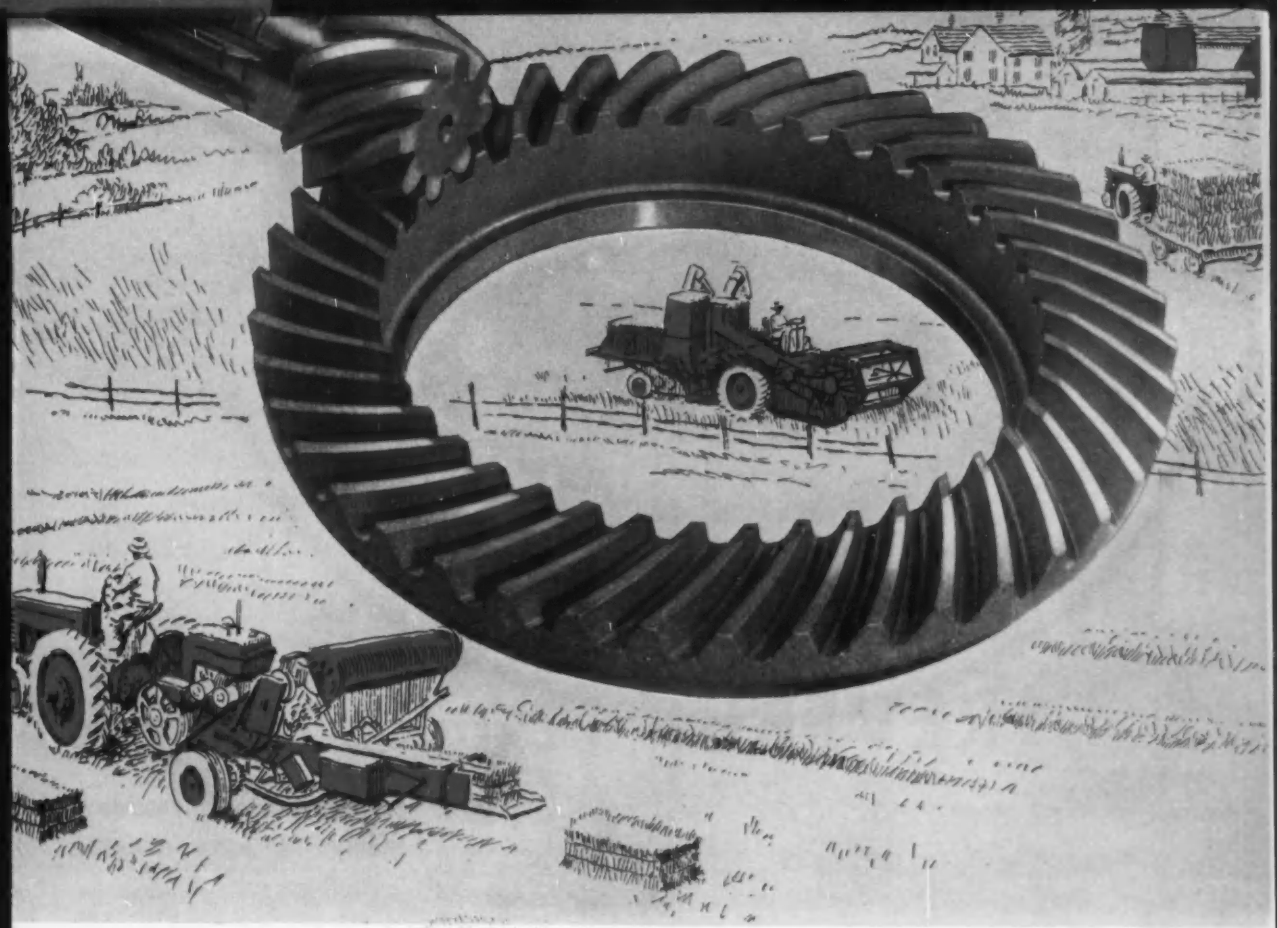
CHICAGO RAWHIDE MANUFACTURING COMPANY
1237 Elston Avenue • Chicago 22, Illinois

Offices in 55 principal cities. See your telephone book

In Canada: Manufactured and Distributed by
Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario
Export Sales: Geon International Corp., Great Neck, New York

SIRVENE C/R DIVISION
CHICAGO RAWHIDE

Other C/R Products
C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears



AGRICULTURE–geared to modern production standards

Unlike industrial machinery, farm equipment is exposed to everything that nature can throw at it. Soil is the element in which farm machines work. They're exposed to every fury in the book—heat, cold, snow, ice, dust. They stand idle much of the time, then go to work at an instant's notice, performing perfectly for hundreds of gruelling hours. And they must be built against breakdown that interferes with the critical time schedules of much farm work.

That gears of our manufacture are specified for so many different kinds and makes of farm machinery is proof of their rugged ability to perform reliably under the most rigorous circumstances. Their daily work on America's farms proves their fitness for service in your products or equipment.

Why not write today for further information?

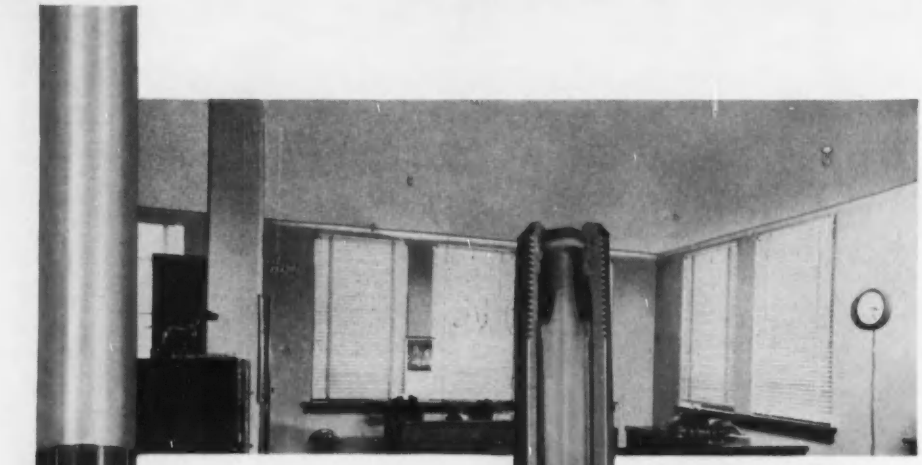
DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914 — RICHMOND, INDIANA

SUBSIDIARY OF EATON MANUFACTURING COMPANY



Office with concealed piping, only the heads showing

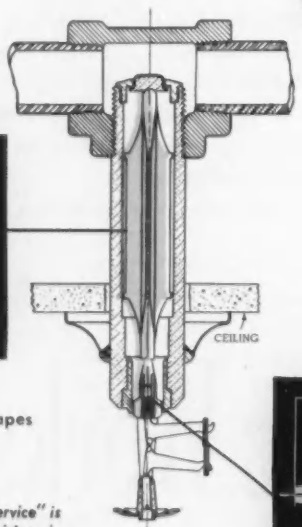
REVERE Extruded Shapes

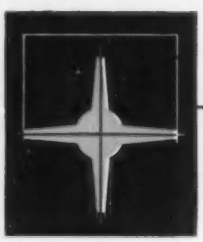
in dry pendent sprinkler heads lessen machining, save money

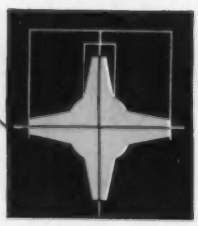
Some 16 years ago the Viking Corporation, Hastings, Michigan, decided to find a way to put sprinkler piping for dry pipe systems above the finished ceiling, leaving only the sprinkler heads visible. This meant designing a sprinkler head which would be free of water except when in use. Thus there would be no drainage problem, and no chance of freezing. The dry pendent sprinkler head as finally developed extends into the sprinkler pipe, where a bronze cap keeps the entire valve waterless. When a fire occurs the usual fusible element melts, two struts drop, releasing the cap and permitting water to flow.

In the original experimental work, the two struts were machined out of solid brass bar. This took time and involved the generation of a considerable amount of scrap, since each strut has four deep fins. Once the idea had proved itself, Viking came to Revere for extruded shapes, in order to save both machining and metal. So much time has elapsed since the original machining of the bar that comparative cost figures would be meaningless, but it is evident to Viking, and to everybody familiar with extruded shapes, that the saving is substantial.

Cross section of Viking Dry Pendent Sprinkler Head, and cutaway view







Outline of the two shapes supplied by Revere

"The Revere Four-Way Service" is a 16mm. sound motion picture in color, educational and informative. If you haven't seen it, write nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

Product Engineering

JUNE 1956 Vol. 27 No. 6 The McGraw-Hill Magazine of Design Engineering

Analysis of Oscillatory Motion Using High Speed Photography.....W. G. Hyzer 135
Derivation of timing and measuring accuracy; study of a vibrating spring and motion of a solenoid armature.

Designing Composite Members.....Reiner J. Auman 140
Stress and deflection formulas for members made of materials with different elastic modulus values; graphical solution for composite members with varying cross section.

Design Features in New Products..... 144
Hydraulic spray gun, 200,000 rpm dynamic balancer, manipulator redesigned for production, hysteresis brake for torque tester, motor driven micrometer, ball-supported washing machine, convertible rolling mill, and other significant design ideas.

Calculating Time Lag of Hydraulic and Pneumatic Valves.....Louis Dodge 158
Formulas and curves for calculating the time required by springs and solenoids to open and close valves; design suggestions for increasing the speed of operation.

Strain Gage Balancing Simplifies Multiple-Bridge Measurements....Peter K. Stein 161
How to design single-arm balancing networks for multiple common circuits.

Locking Mechanisms for Hydraulic Actuators.....R. A. Chace 164
Five methods for locking the piston of a hydraulic cylinder under load.

Plastics for Structural Uses—A Staff Report..... 167
Review of recent developments in thermoplastic and thermosetting molding materials; mechanical properties, chemical resistance, dimensional stability and heat resistance; new foam, film and sheet materials, new developments in fabricating methods; comparative cost data.

Plastic Springs.....Frank W. Reinhart and Sanford B. Newman 183
Methods of manufacture developed at NBS for helical compression springs for use at 135 F; torsional elastic properties of resins and effect of glass reinforcement.

Corrosion Resistance of Titanium.....Andrew N. Eshman 187
Resistance to galvanic and chemical attack; comparison with stainless and aluminum.

How to Measure Surface Finish Inside Tubes.....C. R. Lewis 190
Procedure for a numerical surface finish rating for bores of cold worked tubing.

Designing Screw Machine Parts.....Earl A. Theroux 192
Tolerances and machine performance data for parts made from free-machining stock.

Developments in Sprayed Metal Coatings.....Herbert S. Ingham 194
Powder spray methods for metal alloys and ceramics; comparison of guns, fusing characteristics and properties of coatings produced by new methods.

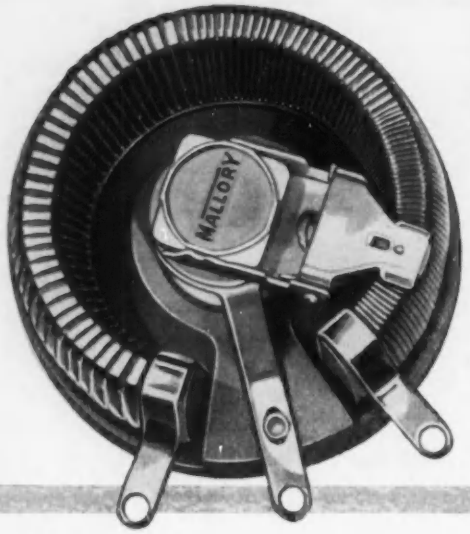
Fan Cooling—Influence of Altitude.....J. Constant van Rijn 198
How variations in air density and temperature affect heat transfer at altitudes from sea level to 15,000 ft; effect of shaft speed, fan diameter, and power frequency.

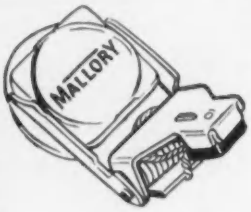
Screw-Holding Power of Polyester Laminates.....R. R. Dixon 217
Results of tests on ¼ in. panels; holding power as a function of hole diameter.

DEVELOPMENTS TO WATCH...5
DESIGN PERSPECTIVES.....129
EDITORIALS.....133, 214
TECHNICAL NEWS.....202
COMING EVENTS.....213
NEW COMPONENTS AND MATERIALS..222
CATALOGS AND BULLETINS.....316
SANS, SOUCI.....342
ENGINEERING ABSTRACTS..346
NEW BOOKS.....377
READERS' LETTERS.....423
PRESS PREVIEWS.....430

Number of copies printed this issue 37,048

MALLORY





Contact troubles are prevented by the exclusive Mallory hinged contact arm, which always maintains correct pressure, allows easy brush cleaning.

Mallory Power Rheostats

Give Extra Performance . . . *Without Extra Cost*

Mallory
Wire Wound Resistors
for heavy duty service

A comprehensive line of vitreous enamel power resistors made by Mallory meets the requirements of many electrical and electronic circuits where high power dissipation is needed . . . in voltage dividers, bleeders, load or shunt resistors.

Mallory resistors are space-wound on high quality steatite cores, using large gage wire with matched temperature coefficients of all parts. They are designed for maximum heat dissipating area, to assure cool operation. A special non-porous, non-alkaline vitreous enamel coating gives effective protection of the winding.

Fixed and adjustable types are available in ratings from 5 to 200 watts. Write for data.

Famous for long service, Mallory power rheostats offer you many unique features of design that assure trouble-free operation, and economical cost.

The hinged contact arm eliminates variation in brush pressure that can cause overheating or failure. The spring carries no current . . . cannot soften when overloads occur. You can lift the brush for cleaning, and the spring snaps it back to correct pressure.

You can depend on Mallory rheostats for cool operation. They are designed with ample ventilation, and conservatively rated. Depend on them for stability, too . . . obtained through the use of high grade ceramic insulation, and tough, impervious vitreous enamel protective coating on the winding. Depend on them for accurate linearity . . . the result of Mallory precision winding methods.

Most tapered windings can be produced with a single size of wire, by means of special Mallory variable pitch winding techniques. This method of construction eliminates joints, hot spots and points of excessive wear . . . reduces rheostat cost.

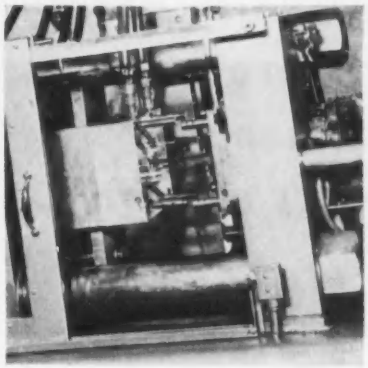
Standard Mallory rheostats cover the complete range from 25 to 500 watts. For your special requirements, our engineers can design single or multiple units to fit your application. Write today for our latest Technical Bulletin.

Expect more . . . get more from

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



THIS MONTH'S COVER

New automatic injection molding machines feature positive ejection and produce finished de-gated pieces. Manufactured by F. J. Stokes Machine Company, Inc., this machine is installed at Sawyer's Inc., Portland, Oregon. One operator can handle as many as 10 machines since, after starting, all it requires is occasional checking. For further data, see page 181.

THE STAFF

Editor **G. F. NORDENHOLT**
Managing Editor ROBERT W. CARSON

Asociate Editors
ROBERT E. ABBOTT • HENRY E. COOK, JR.
RICHARD M. KOFF • JAMES R. McDERMOTT
FORD R. PARK

Assistantant Editors
PAUL N. ANDERSON • NICHOLAS CHIRONIS
JOHN KOLB • NORMA J. VAN NESS

Editorial Assistant LILLIAN M. WITHAM

Consulting Editors
JOSEPH KERR • ROBERT E. BRUCKNER

Washington GEORGE B. BRYANT, JR.
London RICHARD A. LAWRENCE

Publisher ALBERT HAUPTLI

Advertising Sales Manager, STANLEY J. ALLING
Manager, Market Research HUGH BRITTON
Reader Service Manager C. C. KANE
Business Manager RUSSELL T. DOUGLAS

Foreign News Bureau: LONDON • PARIS • BONN • RIO DE JANEIRO • MEXICO CITY • TOKYO • BOMBAY

Product Engineering
A McGRAW-HILL PUBLICATION

JUNE, 1956 Vol. 27, No. 6

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc., Executive, Editorial, Advertising and Subscription offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Orders must indicate company and position. Allow one month for change in address.

Single copies 50¢. United States and possessions, $3 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $9 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Second class mail privileges authorize at Albany, N. Y. U. S. A.

Copyright 1956 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Developments

To Watch

A NEW STRESS ANALYSIS TECHNIQUE . . . .

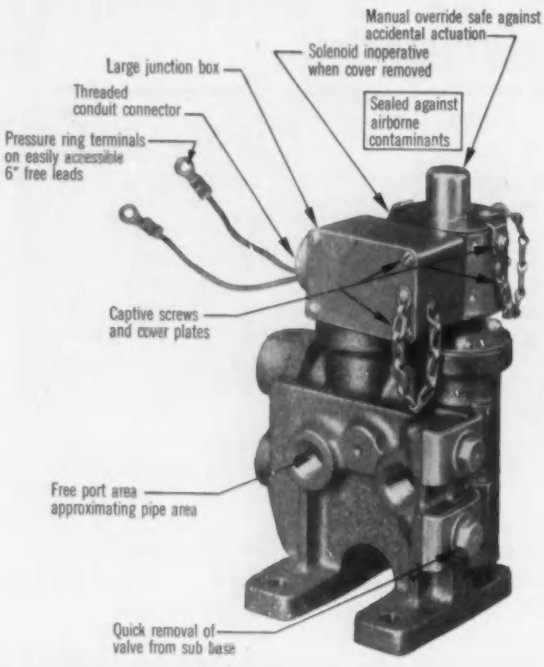
. . . . using conventional photo-elastic methods, permits the direct determination of the stresses in the actual structure, and eliminates the plastic model of the part formerly required. The new method uses a new photo-elastic plastic called Photostress, which was developed by Dr. F. Zandman, a French engineer and manufacturer now associated with Marc Wood International, Inc., 30 Rockefeller Plaza, New York 20, N. Y. This plastic material is bonded to the part to be stress-analyzed. When a load is applied, the strains are transmitted to the plastic coating which then becomes birefringent. With a reflective surface (with emery paper, rough grinding or silver spraying) on the structure, or on the face of the plastic bonded to it, polarized light illumination creates colored fringe patterns which reveal the geography of the mechanical strains in the structure. By visual observation, the magnitude of the stresses can be measured at every point with an approximation of ± 20 per cent, and their directions within 1.5 deg. Viewed with optical instruments, accuracy is equal to that of a strain gage. The plastic can be produced in liquid form, or in sheets or plates from which strips are cut. The liquid and strips differ materially as to their characteristics and use. These can be produced to have uniform stress optical properties, and thickness is maintained to fine tolerances. The flat strips can be shaped to fit any simple contour, and are bonded to the part with an adhesive which dries at room temperature in 24 hr. The liquid plastic is necessary for the stress analysis of very small parts, components having closely spaced rivets, or recesses with small radii, weldments, and whenever the elongation is greater than 2 per cent. The properties of the plastic are not affected by ordinary temperature changes (44 to 80 F), and corrections can be made for temperatures outside this range.

Two kinds of the photo-elastic plastic, which differ by their stretching capacity are available. "AR" will take elongations up to 3 per cent at room temperature, but has high optical stress sensitivity. Elongations up to 30 per cent are possible by increasing the temperature. Plastic "GE" will withstand elongations up to 50 per cent, but has a low optical stress sensitivity. It is used to study the behavior of sheet metal during drawing or laminating, and in problems of extreme plastic deformation. Measurements can be made on structures immersed in any transparent liquid such as water, oil, or gasoline. Also, static and dynamic tests with the same plastic coating can be made as many times as desired.

A PRODUCTION FACILITY FOR VACUUM BRAZING . . . .

. . . . is reported to be successfully brazing intricate honeycomb structures, complex casting assemblies, and precision wave guide and microwave assemblies. Temperatures to 2100 F can be maintained at a high vacuum (10^{-5} mm), and the process lends itself to

(*Continued on page 7*)


Manual override safe against accidental actuation
Solenoid inoperative when cover removed
Large junction box
Threaded conduit connector
Sealed against airborne contaminants
Pressure ring terminals on easily accessible 6" free leads
Captive screws and cover plates
Free port area approximating pipe area
Quick removal of valve from sub base

For Machine Designers Who Want More Than Just 'JIC' Compliance, the Crescent® 4-Way Valve

®Product of Crescent Valve Company for the control of air, water and light oil to 150 P.S.I.

Pointed out on the photo above are the JIC features which are a must for many equipment manufacturers to gain acceptance of their machines in a growing number of production conscious plants. However, they offer obvious advantages even where they are not specifically demanded. Furthermore the JIC type Crescent solenoid is completely interchangeable with standard solenoids for the convenience of those manufacturers who want the JIC features available only for required application.

COMPETITIVE

With all its superior operating features the Crescent valve is probably the most competitively priced line on the market, particularly in the light of liberal trade and quantity discounts.

COMPACTNESS

Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

INTERCHANGEABILITY

Crescent valves can be converted to any practical current or voltage AC or DC by a simple coil change.

NO COIL BURNOUT

Short stroke, pilot operation and a generous power margin prevent overheating, overloading and the resultant coil burnout.

Write for Catalog 6-C

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

ARE YOU CHANGING DESIGN ON AIR OPERATED MACHINES TO CUT COST AND IMPROVE OPERATION?

*$18.50 is the list price for the ¼ inch port size and $19.50 for the ⅜ inch, less the usual quantity and trade discounts.

HERE'S BOTH LOWER COST AND BETTER CONTROL IN THE 'SHEAR-SEAL' 4-WAY AIR VALVE

You need no oiler and filter ahead of this valve because it's made entirely of corrosion resistant materials and moisture won't harm it.

It operates freely on dry, unlubricated air, and dirt or pipe scale in the line cannot damage the valve or hold it open because of the unique "Shear-Seal" design.

The leak-proof holding quality which does not diminish after prolonged service is perhaps the most outstanding characteristic of the wear-compensating "Shear-Seal."

The external design stresses savings through convenience of porting, any port can be the "in" port; of mounting, valve has a bracket that may be shifted or removed to make way for panel mounting; of maintenance, valve can be serviced without touching the plumbing.

Ask for bulletin A-5.

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

brazing problems of the newer alloys. The purge and flow properties produced in vacuum, permit surface areas of several square feet to be bonded without voids or inclusions. No flux is used, and Kinetics Corp., 349 Lincoln St., Hingham, Mass., owners of the facility, claim that tests of the bonds closely approach the strength of the parent metal. Due to outgassing, ductile joints are produced that will permit post braze straightening. Assemblies up to 32 in. in dia and 27 in. long can be handled.

A NEW AIR COOLED ROTARY HIGH VACUUM PUMP . . . .

. . . . uses a radiator cooled lubricating system to replace the conventional watercooled vacuum pump. The feature of the new line, with 15 to 40.8 cfm capacities, is continuous duty (24 hr a day) operation at 29.9 Hg vacuums with an average pump temperature of 140 F compared to 250 F for watercooled models. Made by Leiman Bros., Inc., 146 Christie St., Newark 5, N. J., the low pump temperature is maintained by circulating pre-cooled standard SAE 30 lubricating oil to the interior of the pump. This reduces the heat on the pump parts and prevents excessive metal expansion while increasing the pump's volumetric efficiency. Speeds up to 800 rpm are used. The oil also provides a seal for the vacuum, and the low temperature keeps the viscosity of the oil at a point where the best lubricating film is maintained. The cool oil also eliminates the vapor problem. From the pump and bearings, the oil drops to a sump before being circulated through the fan cooled radiator. A self-contained unit, the pump can be placed anywhere, and needs no cooling water connections.

FEWER PARTS IN NEW MAGNETIC AMPLIFIER . . . .

. . . . developed by the Magnetics Div. Engrg. Dept. at the U. S. Naval Ordnance Lab., White Oak, Md. It is simple in design and offers an improved performance, with up to 65 per cent fewer static parts than normally required. The amplifier makes possible a power gain of about 5000 to 1 with a single stage of amplification. The single stage gain is sufficient for many uses, and is obtained without any sacrifice in input impedance level.

ANOTHER CAUSE FOR THE ENGINEER SHORTAGE . . . .

. . . . revealed in a recent survey by the Carnegie Institute of Technology, Pittsburgh 13, Pa., showed that a majority of science and engineer alumni are in the higher echelons of administration and management. Questionaires were sent to 18,000 alumni, and 95 per cent were returned. Roughly, two-thirds, or 11,500, hold bachelor, master, or doctoral degrees in engineering or science, but only 2391 listed their occupation as engineer. Over one thousand are company presidents, vice-presidents, and general managers. Engineers have chosen careers in the fields of editing, sales, education, medicine, law and politics. Twenty became clergymen, and three missionaries.

ADDITIONS OF ZIRCONIUM INCREASE FATIGUE LIFE . . . .

. . . . of cast aluminum-brass alloys, according to experiments performed at the British Non-Ferrous Metals Research Establishment. While the mechanism is not yet understood, creep behavior is not materially altered, and the addition of zirconium has little effect upon the fatigue life of wrought alloys. The addition of

(Continued on page 9)

When you demand high uniform quality, *you use Bonderite under the paint.*

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

SEAL WITH A MEANING

The red and silver Bonderite seal on your products will tell buyers, "This Product Will Look Better Longer," 25 years of national advertising backs up this seal. Write to find out how you can cash in on it.

● When you see the smooth, tight-grained, uniform Bonderite coating move past the inspection station, you know your final paint film will be smooth, even and lustrous.

There's another point to mention here. As production men know, when inspection finds high uniform quality on the paint line, there'll be mighty few field refinishing costs to bite into profits.

High uniform quality is just one of the advantages Bonderite delivers. Let us tell you the rest of the story. Write or call today.

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

Since 1914 — leader in the field

PARKER RUST PROOF COMPANY
2719 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

0.04 per cent zirconium to a test specimen raised its life from 24 hr to 49 days under the same cyclic loading conditions. When immersed in a 3 per cent salt solution under cyclic load, the same alloy percentage increased life of the test specimen from 2 days to over 240 days.

AIR ACTUATED CONTACTORS PREVENT SWITCH WEAR . . . .

. . . . on a new telemetering switch developed by the Rabinow Engineering Co., 7212 New Hampshire Ave., N. W., Washington, D. C. In the new switch, there is no rotating leaf spring contact to wear away the corresponding contacts on the board. Instead, each contact on the board has a leaf spring contact facing but not touching it. This second contact is depressed, and the circuit closed by a high pressure jet of air which is emitted from a single hole in a rotating disk passing over it. With this technique, several thousand closures per second are possible, because there are no limitations imposed by inertia effects associated with the usual wiping or wearing of the contacts.

A LOCK AND SEAL ACTION . . . .

. . . . between a nut and bolt is obtained by applying a special plastic to the threads of the bolt. No special lock nut or lock washer is necessary. Both the plastic and the machine for applying it are being developed for the Lamson & Sessions Co., by the Arthur D. Little, Inc. research firm of Cambridge, Mass. The nut can be taken off and reapplied 15 times without any detrimental effect upon its lock and seal qualities. The plastic gives a locking action on a bolt in a tapped hole as well as with a nut. The machine for applying the plastic seal will handle bolts in the range from ¼ in. in dia down to a No. 10 screw. Lamson & Sessions will apply the sealant to the bolts on order, according to the breakaway torque desired.

AND IN ADDITION . . . .

. . . . Gallium, a seldom used metal is finding a promising application as a sealant in glass joints and valves in laboratory vacuum equipment, the Alcoa plant at East St. Louis, Ill. reports. . . . Pres. Eisenhower just became an honorary member of the ASME. . . . The first commercial production of titanium sponge in the U. S. by the sodium-reduction process (all others are by magnesium reduction) has been accomplished by the Electro Metallurgical Co., Div. of Union Carbide & Carbon Corp.; located at Ashtabula, Ohio, the plant will have a capacity of 7500 tons of titanum sponge per year. . . . Single cylinder steam turbines are being installed on U. S. ocean going merchant ships for the first time since World War I, according to G. E., Lynn, Mass., manufacturers of the new units; occupying less space than the conventional cross-compound units, the turbine will produce 6000 hp at 120 rpm. . . . Battelle Memorial Institute, Columbus 1, Ohio, is continuing its study of the life expectancy of thermoplastic pipe; the program is being sponsored by plastic pipe manufacturers, and material suppliers interested in getting some long-term data on plastic pipe under different service conditions. . . . Adding a small percentage of the element tellurium to lead will double its strength and increase its resistance to vibration, heat, and corrosion. . . . The National Bureau of Standards has a project from the Post Office Dept. to study the possible mechanization of mail handling; this will include: the transfer of information on the letter to the machine; a memory which will know to what part of the country the letter will go; and physical handling and sorting.

Two Ways Armco ZINCGRIP Steel Tubing May Help You Cut Costs, Build Sales

Typical applications where ZINCGRIP Tubing helps build sales and cut costs.

Besides the cost-saving design possibilities offered by steel tubing, Armco ZINCGRIP Tubing can give your products a big plus value: **It is the protection of a special zinc coating.**

Long Product Life

The mill-applied, hot-dipped zinc coating, on inner and outer walls of the tubing, is assurance of extra durability for your products . . . more satisfied customers. And the smooth, attractive finish of ZINCGRIP Tubing can give your products another powerful selling point.

Economy in Fabrication

With ZINCGRIP Steel Tubing you can take full advantage of the weight reductions possible with rigid tubular construction. Easy-to-fabricate, lighter-weight products can save you money and help boost sales.

You can bend, join, flange, upset or bead Armco ZINCGRIP Tubing on standard equipment. The special zinc coating *stays on* . . . doesn't flake or peel in fabricating operations.

For Your Products?

Manufacturers of conveyor rolls, farm equipment, lawn mowers and sweepers, TV antennas and scores of other products are making profitable use of Armco ZINCGRIP Steel Tubing. Why not consider its advantages for the products *you* make or use?

Just fill out and mail the coupon. We'll send you complete information.

ARMCO STEEL CORPORATION
1526 Curtis Street, Middletown, Ohio

Send me more information on Armco ZINCGRIP Steel Tubing.

We manufacture_____

Name_____

Company_____

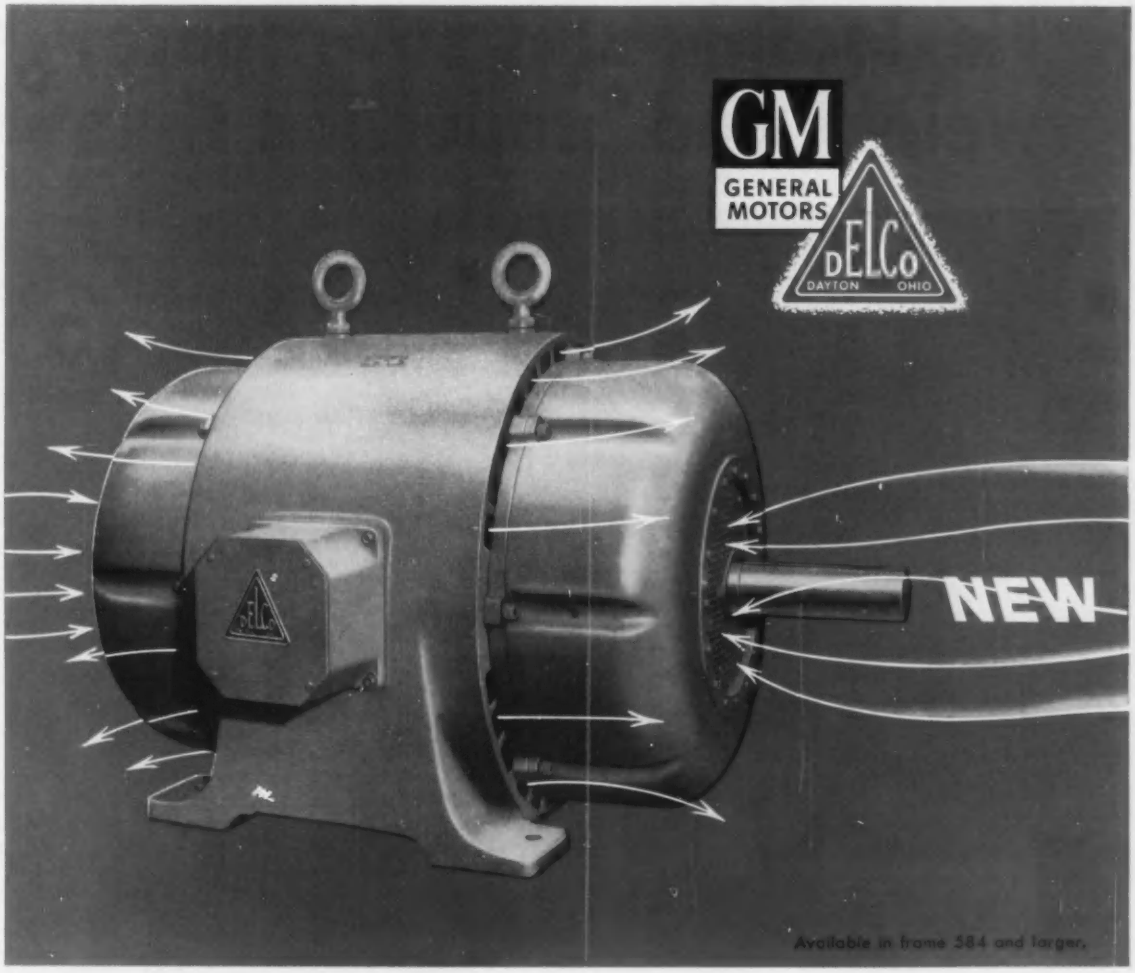
Street_____

City_____ Zone____ State_____

ARMCO STEEL CORPORATION
1526 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

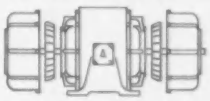


Both bearings get cool air in new DELCO Electric Motors!

Better cooling increases bearing life and reduces maintenance on heavy-duty TEFC units

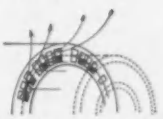
Two fans, each strategically located near one of the bearings, give these large totally-enclosed, fan-cooled Delco Electric motors a more effective cooling system. The bearings get the coolest air first. Then, the entire motor is evenly cooled as the air moves rapidly through special tunnels built in the wall of the main frame. This remarkable new system assures quiet air flow, increased bearing life and less need for maintenance. It's another example of how Delco Products engineering leads the way in solving your motor problems to provide more value, more consistently good performance on every application. Contact your nearby Delco Products distributor or sales office now for *all* your motor requirements.

HERE'S HOW IT WORKS!



Cool air enters at both ends, cools bearings, tunnels across entire motor.

Tapered fans turn cool air inward, scrub heat off vital bearing sites.



Quiet air movement is controlled by large tunnels in motor frame.

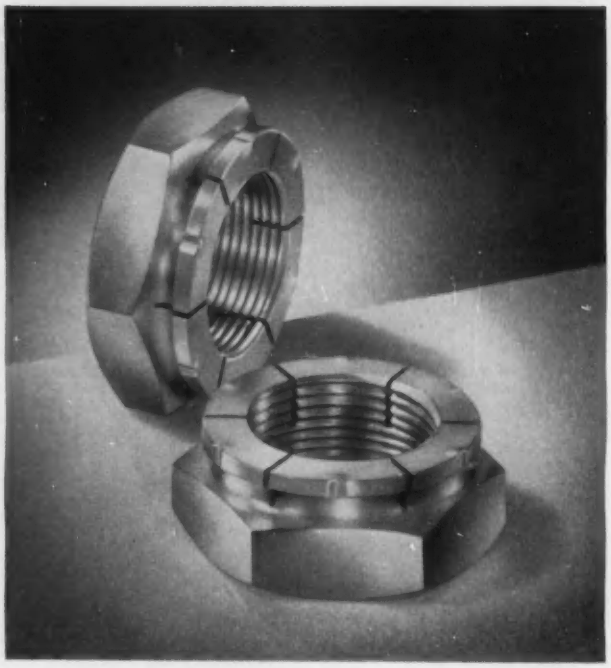
GM GENERAL MOTORS DELCO DAYTON OHIO

DELCO *Electric* MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS, DAYTON, OHIO

Proved best by Performance!

Flexloc thin nuts save space, weight and production time



Self-locking nuts are 30% lower and lighter; speed up assembly with hand or power tools

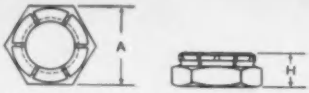
Self-locking FLEXLOC thin nuts are 30% lower than regular height locknuts of the same nominal diameter. They fit into spaces where regular height locknuts will not go. You can design lighter, more compact units with them.

Where you must reduce weight in a completed assembly, you can save by using shorter bolts with these lighter nuts. And you save production time. The length of engagement of mating threads is shorter: fewer revolutions of hand wrenches or power nut runners are needed to seat them.

FLEXLOC nuts are of 1-piece, all-metal construction. You can use a FLEXLOC fully seated as a locknut or at any point along a bolt as a stop nut. Once the threads in the resilient locking section are fully engaged, the FLEXLOC grips the mating threads with uniform locking torque wherever wrenching stops. Since there are no nonmetallic inserts to come out or deteriorate, the locking life of a FLEXLOC is virtually unlimited.

Your authorized industrial distributor stocks FLEXLOC nuts in a variety of sizes, materials and finishes. Consult him for details. Or write us for information about your special locknut problem. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

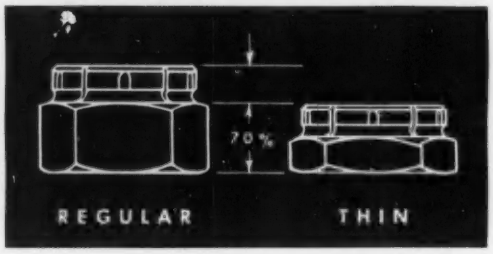
SPECIFICATIONS FLEXLOC THIN NUTS



NATIONAL COARSE THREAD—U.S.S

SIZE	A INCHES	H INCHES	WIDTH ACROSS CORNERS	WEIGHT PER 1000 NUTS
6-32	.312	.125	.361	1.8
8-32	.344	.172	.397	2.8
10-24	.375	.172	.433	3.3
¼-20	.438	.203	.505	5.4
5/16-18	.563	.250	.649	11.6
3/8-16	.625	.265	.722	14.9
7/16-14	.750	.312	.866	24.9
½-13	.813	.312	.938	28.4
9/16-12	.875	.359	1.010	36.1
5/8-11	1.000	.391	1.155	54.1
¾-10	1.125	.406	1.299	69.2
7/8-9	1.312	.469	1.516	107.5
1-8	1.500	.563	1.732	171.6
NATIONAL FINE THREAD—S.A.E.				
6-40	.312	.125	.361	1.8
8-36	.344	.172	.397	2.8
10-32	.375	.172	.433	3.3
¼-28	.438	.203	.505	5.4
5/16-24	.500	.250	.577	8.7
3/8-24	.563	.266	.649	11.5
7/16-20	.625	.312	.722	14.9
½-20	.750	.312	.866	21.7
9/16-18	.875	.359	1.010	36.2
5/8-18	.938	.391	1.082	42.4
¾-16	1.063	.406	1.227	54.5
7/8-14	1.250	.469	1.443	84.6
1-14	1.438	.563	1.660	136.3
1 1/8-12*	1.625	.625	1.876	193.5
1 1/4-12*	1.813	.750	2.093	296.0
1 3/8-12*	2.000	.812	2.309	389.0
1 ½-12*	2.187	.875	2.526	498.0

*Steel only (plain or cadmium plated) in stock sizes.



FLEXLOC thin nuts are 30% lower than regular height locknuts. There is a corresponding saving in weight. In sizes through 5/16 in., thin FLEXLOCS meet tensile strength requirements for regular height locknuts. FLEXLOC nuts can be made in the thin type because every thread, even those in the locking section, carries its full share of the load. There are no nonmetallic inserts to waste head space or weaken the structure of the nut.

Standard FLEXLOC self-locking thin nuts are available in plain or cadmium plated alloy steel, for use in temperatures to 550°F; in plain or silver plated corrosion resisting steel, for temperatures to 750°F; and in brass and aluminum, for temperatures to 250°F.

STANDARD PRESSED STEEL CO.

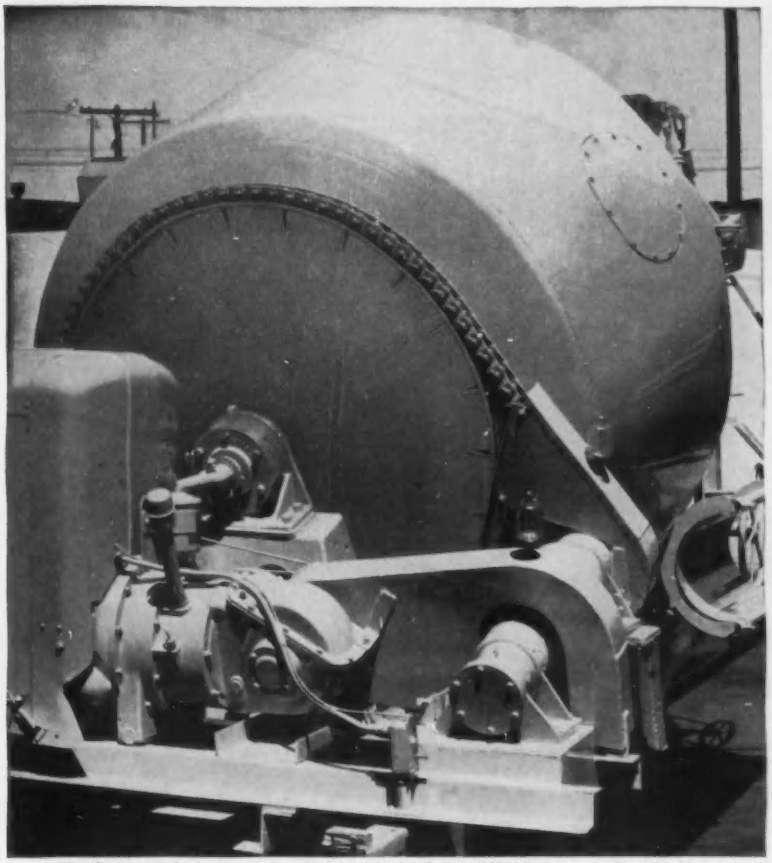
FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

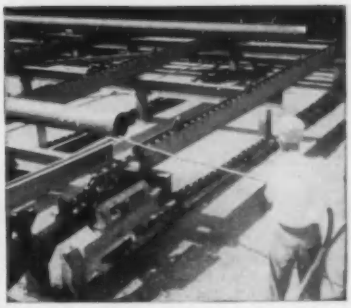
Leading design engineers choose this

Chain for severe conditions

...it's LINK-BELT LXS for drives and conveyors



Truck-mounted concrete mixer is driven by Link-Belt LXS chain (guard removed).



Pipe mill cooling beds use LXS chain with attachments to move heavy pipe smoothly.

Advance-design shovel-crane gets its traveling and steering power through LXS chain.

Accurate sizing of full-round pins, bushings and pitch holes of LXS chain assures proper joint clearances and press fits.

No ONE chain serves every purpose--
get the RIGHT one from Link-Belt's *complete* line

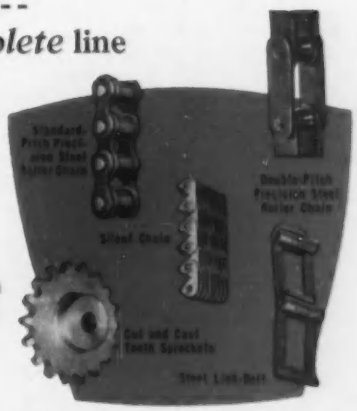
For long life under severe drive or conveyor service, Link-Belt LXS chain is the choice of more and more leading designers. Here's a fabricated steel roller chain that *combines ruggedness with accuracy*, thanks to the manufacturing refinements that are a by-word at Link-Belt.

It's the same story for every drive and conveyor requirement — you'll find the chain that's *best* for the job in the complete Link-Belt line. No other single source can equal Link-Belt's broad range of roller and silent chain . . . of cast, combination, forged and fabricated types.

Your nearby Link-Belt office can give you all the facts. Why not call today for an expert, unbiased appraisal of your needs?

LINK-BELT

CHAINS & SPROCKETS



LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs, Representatives Throughout the World.

Nickel plated inside and out to meet rigid specifications of Atomic Energy Commission, these pressure vessels comprise one of many trainloads fabricated by Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

Designers specify nickel plated vessels to guard product purity

Designers, along with plant operators in scores of industries, find that a reasonable thickness of nickel plating helps in three ways:

First, by guarding equipment against mild corrosive attack.

Secondly, by protecting product purity during the production cycles.

And last but not least, by providing such protection economically.

Operators of food, chemical, petroleum and other process plants have made significant savings by use of nickel plated equipment.

Economical protection

Heretofore, electroplating of large complex shapes posed several difficulties. But thanks to expansion and improvement of facilities, nickel plating is no longer limited to relatively small, simple forms.

Even on the most intricate shapes of low-cost base metals, new techniques now permit plating a uniform, extremely hard, corrosion-resisting coating of nickel that offers sturdy protection.

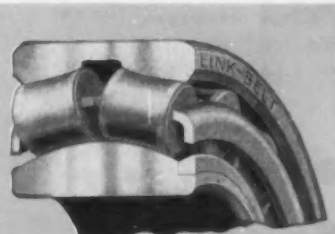
Dependability of advanced methods has made it practicable to nickel-plate large quantities of equipment to meet exacting demands of the Atomic Energy Commission. Likewise to meet needs of commercial installations.

Consider how you, too, can save money by use of nickel plating to resist corrosion or to protect product purity. And at the same time cut initial cost of the equipment. Plating with Inco nickel has solved numerous problems. It may be the answer you seek. So send us the details of your metal difficulty. We'll be glad to give you suggestions based on our long practical experience. Write us today.

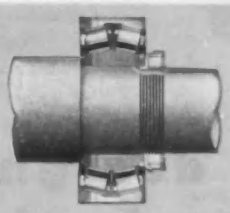
INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

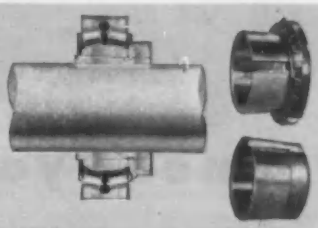
ALLIS-CHALMERS MOTOR GRADER capitalizes on the ability of Link-Belt self-aligning roller bearings to handle high shock loads.



FREE-ROLLING — SELF-ALIGNING. Spherical inner ring is free to align in any direction. Load is distributed over entire roller assuring full load capacity. Destructive edge loading cannot occur.



DIRECT SHAFT MOUNTING with bearing being pressed or shrunk on the shaft. Especially desirable to achieve maximum economy on production applications.



ADAPTER MOUNTING permits use of commercial shafting without machining. Easy installation and removal of adapter-type bearings are provided by the tapered sleeve, locknut and lockwasher.

Builders of industry's heaviest equipment

choose this self-aligning roller bearing for toughest applications

You're in company with blue-chip machinery makers when you specify high-capacity Link-Belt self-aligning roller bearings. Wherever tough-duty equipment calls for self-contained, pre-adjusted bearings and simple mounting, you'll find them on the job . . . handling heavy radial and thrust shock loads.

These self-aligning roller bearings have internationally standardized boundary dimensions and are available everywhere. Link-Belt also makes industry's most complete line of ball and roller bearing blocks. This includes pillow blocks plus flange, flange cartridge, cartridge, take-up and hanger blocks. Ask any one of the 40 Link-Belt offices for data Book 2550.

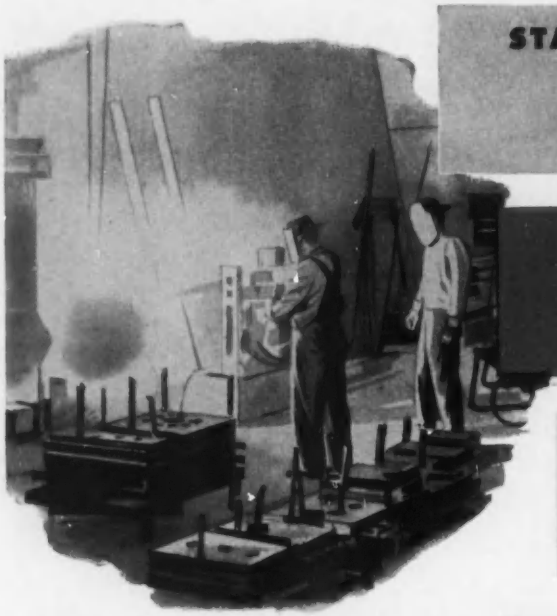
LINK-BELT

Ball and Roller Bearings 13,359-A

Bearing boundary dimensions are international standards for Series 22200 and 22300—22500-A and 22600-A.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

WAUKESHA casts all 3



STAINLESS STEEL

Group I — Martensitic
Group II — Ferritic
Group III — Austentic

NON-FERROUS

Monel Pure Nickel, Inconel
Brass and Bronze, Aluminum
Everdur, Aluminum Bronze

WAUKESHA METAL

Copper Base, High Nickel Content Corrosion-Resisting Alloy. Developed and Produced Only by Waukesha Foundry Company.

to meet your design needs... in these modern facilities...

● "Top" product designs and process equipment in every field require "top" castings.

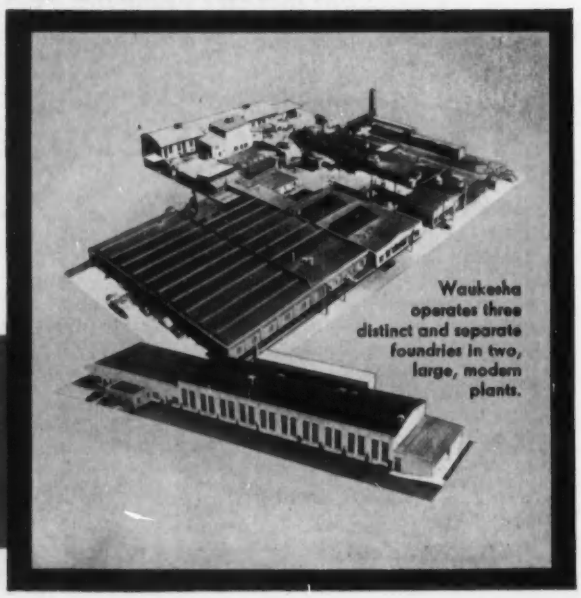
Especially is this so where there is a critical corrosion-resistant casting design problem combined with one of hardness, or strength, elongation, wear resistance, bearing qualities, impact, scale resistance, seizing or galling, or intergranular corrosion among others.

Waukesha has the right metal and the casting ability to produce castings precisely to specifications... castings that stand up to the severe demands of today's designs and process equipment demands.

Metallurgical laboratory control guarantees you castings that are uniform, close-grained, free of porosity, metallurgically accurate in composition, and dimensionally correct—real assets to your products.

We suggest that you write for a casting quotation or engineering counsel.

Waukesha Foundry Company,
5603 Lincoln Avenue, Waukesha, Wisconsin.



Waukesha operates three distinct and separate foundries in two, large, modern plants.

Waukesha Foundry Company
WAUKESHA, WISCONSIN

WAUKESHA—SPECIALISTS IN CORROSION-RESISTANT CASTINGS FOR ALL INDUSTRIES

THE

A B C

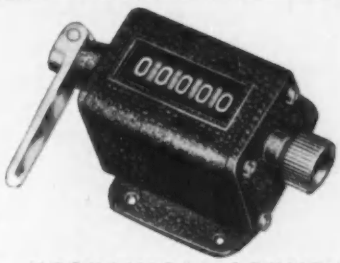
OF

1 2 3

Why is COUNTROL

important in every business today?

Countless times a day, every business needs to know "how many? . . . how much? . . . how far? . . ." and many other questions that can be answered only by facts-in-figures. But how to get these figures . . . from so many different machines, processes, operations and systems? Veeder-Root Counters are doing it every day, by means of:



MECHANICAL COUNTING

Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.

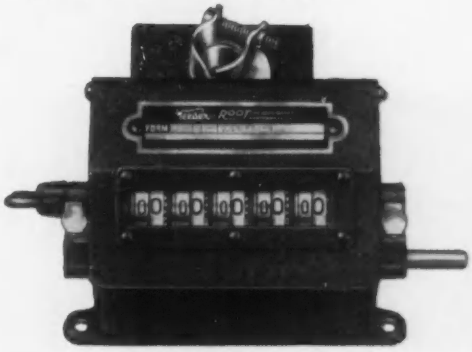
Insist on Standard

VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor

ELECTRICAL COUNTING

These remote-indicating counters bring your production machines as close as your office wall. AC or DC, they can be connected in series with any simple switch, and will transmit production figures *instantly* over any distance. May be panel-mounted in groups.



CONTROLLING

Set it for the exact number of turns, pieces, or operations required . . . and this Predetermining Counter will control the run *exactly* . . . preventing over-runs and shortages. When the predetermined number is reached, counter will light a light, ring a bell, or actuate a stop-motion.

IN SUM: *If it can be counted or controlled . . . count on Veeder-Root to do it. Get in touch with your Industrial Supply Distributor for standard counters for application to your production machines and processes. And get in touch with Veeder-Root for counters to be built into original equipment.* **Veeder-Root Inc., Hartford 2, Connecticut.**

MONSANTO

Today's industrial designers face a dual challenge in the race to outdistance competition. Their products must be more pleasing in appearance, more efficient in performance. Many of these designers are working closely with plastics engineers in the custom molding industry to achieve both goals simultaneously. Read how one of America's leading manufacturers of air conditioning units improved sales in a fiercely contested market by utilizing the unique properties offered by plastic materials.

New housings of Lustrex Styrene plastic are building business for Fresh'nd-Aire

DESIGN OBJECTIVES. In creating a new line of air conditioning units, the management of the Fresh'nd-Aire Company, division of the Cory Corporation, Chicago, required an interior housing with many advanced features. The new housing had to have sleek decorating styling to make it an outstandingly handsome piece of furniture. It had to incorporate tight-fitting removable parts. It also had to be produced at reasonable cost.

MATERIAL SPECIFICATION. Careful testing by Fresh'nd-Aire engineers proved that Lustrex high impact styrene offered the most desirable characteristics. A styrene housing could be economically produced with an attractive, soft-lustered, surface-to-surface coloring in the specified shade. This eliminated six costly painting and cementing operations. Injection molding techniques for high impact styrene freed designers from the restrictions of metal die-stamping machines. Modern smooth-flowing lines could be obtained. There was no danger of rust or corrosion deteriorating the housing. Furthermore, Lustrex high impact styrene provided a strong base for rivets, bolts and other anchoring devices. This tough Monsanto styrene also demonstrated its ability to hold critical dimensions. Parts like reversible vents and a front cover accessory panel could be removed and replaced repeatedly without the hazard of bending out of snug fit.

PRODUCTION ENGINEERING. General American Transportation Corporation, Chicago, was commissioned to supply the styrene housing for Fresh'nd-Aire. Every design requirement was satisfactorily met by molding the component of Monsanto Lustrex Hi-Test 88, a rubber-modified high-impact styrene. The part is produced in a hydraulic 1500-ton press and contains 40 ounces of the Monsanto styrene material.

THE FINISHED PRODUCT. The new Fresh'nd-Aire unit has earned the hearty approval of both trade and public. Sales officials agree the change to styrene components has improved the marketability of the line. The interior housing and exclusive "Style-Gard" accessory panel have added vital style interest to the unit—and improved its performance. A 300% sales increase over last year is anticipated for the 1956 season.

This is one of hundreds of design and production problems which have been solved by utilizing the facilities of the plastics custom molding industry. These 20th Century craftsmen are available to manufacturers designing for greater efficiency and lower costs. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who will put their skills to work for you. If you are considering a design change for your product line, be sure to investigate plastics. Write to Monsanto Chemical Company, Industrial Applications Dept., Room 906, Springfield 2, Mass.

Investigate the Monsanto completely-balanced line of styrene plastic compounds developed for particular applications and sold under the trade name . . .

LUSTREX
Styrene Plastic

MONSANTO

the characteristics of ARMASTEEL®

from the STANDPOINT OF

by

HAROLD G. SIEGGREEN

Chief Engineer
Central Foundry Division
General Motors Corp.

One of the many problems which today confront the engine designer emanates from the restricted space in the crankcase. Here is what I mean . . .

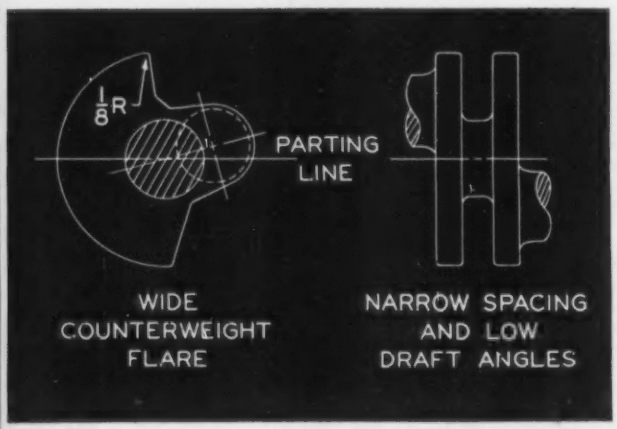
Automotive sales departments are perennially pressing the engine designers for better performance to keep up with competition. By applying the results of research, the design engineers have been able to partially satisfy the demand by increases in compression ratio, freer breathing and improved carburetion. This is accomplished, of course, by larger valves, high lift cams, and by multiple carburetors.

Because there is a limit as to how much the maximum horsepower can be increased by changes in breathing, and because of the real need for higher torque, the designer must sooner or later think in terms of larger pistons and/or greater length of stroke. This, in turn, means greater rotating and reciprocating forces which in the new and modern V-8 engine must be balanced by larger counterweights. And up until recently, this presented a serious problem due to the usual restricted area of the crankcase. But now, the problem is solved with relative ease . . . for the shell-molding process allows considerably greater latitude in the design of the counterweights.

With shell casting, it is now possible to flare the counterweights to any desired width (end surfaces can be practically perpendicular to pattern parting) to achieve the maximum balancing effect. Radii of counterweight tips can be consistently cast as low as ⅛" (in other methods of producing crankshafts, the variation on the tips or corners was so great that a 1" radius was usually specified). Shell-cast crankshafts are produced with extremely narrow spaces between the counterweights. In fact, the drawing of deep and narrow pockets of this nature is entirely practical now. (These points are illustrated in my two accompanying sketches).

Another example: draft angles of less than ½ degree are commonly used. All these factors make it feasible to produce the eight counterweight shafts for V-8 engines which many engineers favor because of their ability to decrease crankshaft deflection and loads on main bearings. With shell-cast ArmaSteel, crankshafts can now be made for even the extremely difficult V-6 engine. (See photographs.)

Also from the standpoint of machining, the new shell-cast ArmaSteel crankshafts present substantial advantages. It is now possible to eliminate the cheeking and turning operations on the sides and on the outside diameters of the counterweights on some designs. When these machining operations are necessary to attain maximum counterweight thickness and diameter only a minimum of stock need be removed.



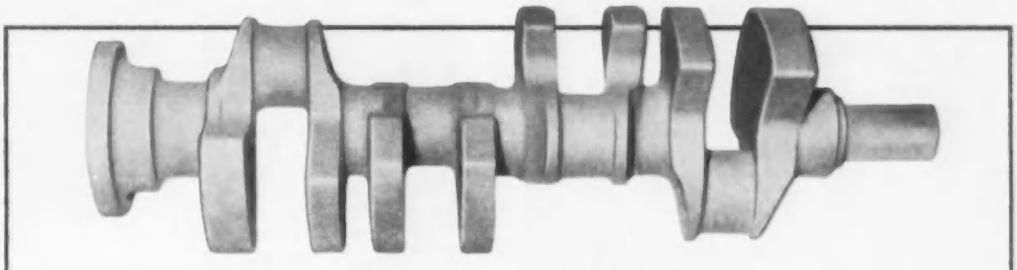
The good dimensional control of shell-cast crankshafts, over long production runs, provides for consistent balance drilling. This dimensional control is due to the negligible pattern wear, and the hard, smooth, and accurate mold. (Shell-molds are bonded by phenolic resin and cured before stripping from the pattern.)

By using accurately machined patterns, with the crankpins positioned, the completed castings provide excellent crankpin index.

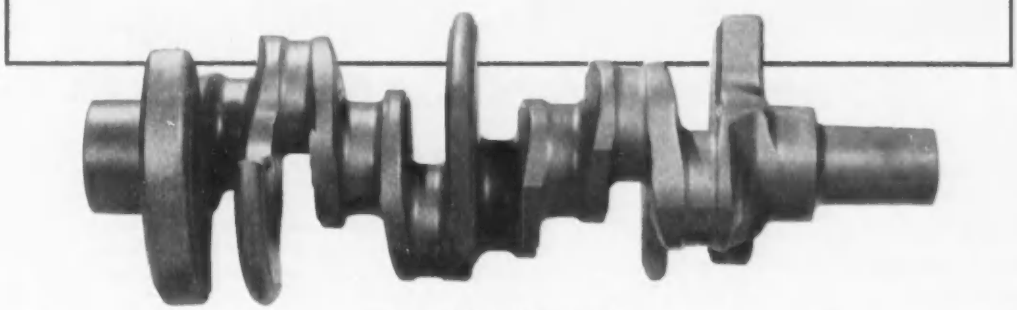
It is the combination of the method, shell-casting, and the material, ArmaSteel, that makes the cast crankshafts so practical. The metal, ArmaSteel, combines the advantages of both castings and forgings. It possesses unusual resistance to fatigue and wear. Its rigidity (modulus 26 to 28 million) results in minimum deflection —therefore accurate alignment. Its high damping capacity allows it to absorb vibrant energy and thus contribute to noiseless operation.

SHELL-CAST CRANKSHAFTS

DESIGN



ArmaSteel 8 Counterweight Crankshaft



ArmaSteel V-6 Crankshaft

Unlike many cast materials, ArmaSteel is ductile and therefore does not break under ordinary handling, machining, or impact loads. Its high tensile strength (90,000 psi for the crankshaft grade) renders ArmaSteel highly desirable not only for crankshafts, but for many other highly stressed components.

ArmaSteel crankshafts are inspected in a great many ways here at Central Foundry Division—both conventional and unique. 100% hardness testing, magnetic particle inspection, and sonic testing (a Central Foundry development) are given each crankshaft. In addition, gamma-ray radiography is used as another control measure. Indication of performance is proven by 3½ years of thorough testing in various types and sizes of passenger car and truck engines. (In extremely critical laboratory and road tests, the ArmaSteel crankshaft remained intact while other engine parts failed.)

The lower specific gravity of ArmaSteel (.2665 lbs. per cu. in.) means a lighter crankshaft. (4 pounds lighter in the case of one popular V-8 engine.)

In my opinion, the biggest reasons for the automotive industry to switch to the shell-cast ArmaSteel crankshaft are the lower net cost plus a greatly improved product. Savings result from: less material purchased; lower freight (because of the casting being so much closer to final dimensions) and considerably less time, labor, tool-wear, etc. in the entire machining and finishing cycle.

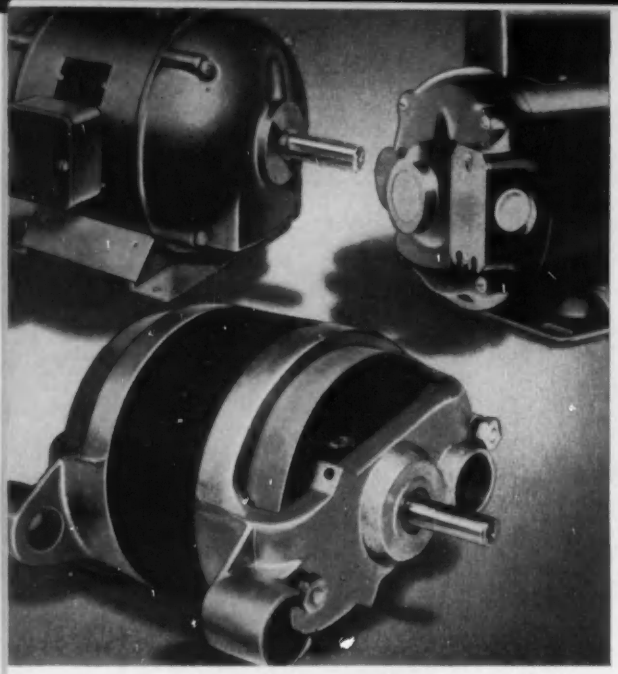
All in all, I believe, shell-cast ArmaSteel promises much for the design engineer, the production engineer, the cost engineer and the ever-demanding sales department.

For information on how your product can also benefit from ArmaSteel, the metal, and Shell Molding, the process, write today for your copy of the "ArmaSteel" catalog and the pamphlet "Shell Molding at Central Foundry."

70

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10



Complete Motors... or Motor Parts

Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*

You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors } FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

ROBBINS & MYERS, INC., MOTOR DIVISION, PD
Springfield 99, Ohio:

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 200 HP
- ☐ Please have a Motor Specialist call

*Product we manufacture:*_____

*Name*_____ *Title*_____

*Company*_____

*Street*_____

*City & State*_____

R&M MAKES BOTH!
Fractional horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 200 h.p.

**"All-Weather" is an R&M trademark*

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

Announcing

4 new Styron

Greater than ever versatility

STYRON 440

high impact strength with heat distortion of 200° F.

Excellent surface finish. Good moldability. For the first time all these properties are combined in one polystyrene. Long needed for superior radio cabinets, appliance housings, cutlery handles, and parts for refrigerators, cars and cameras.

STYRON 429

high impact strength plus improved surface gloss

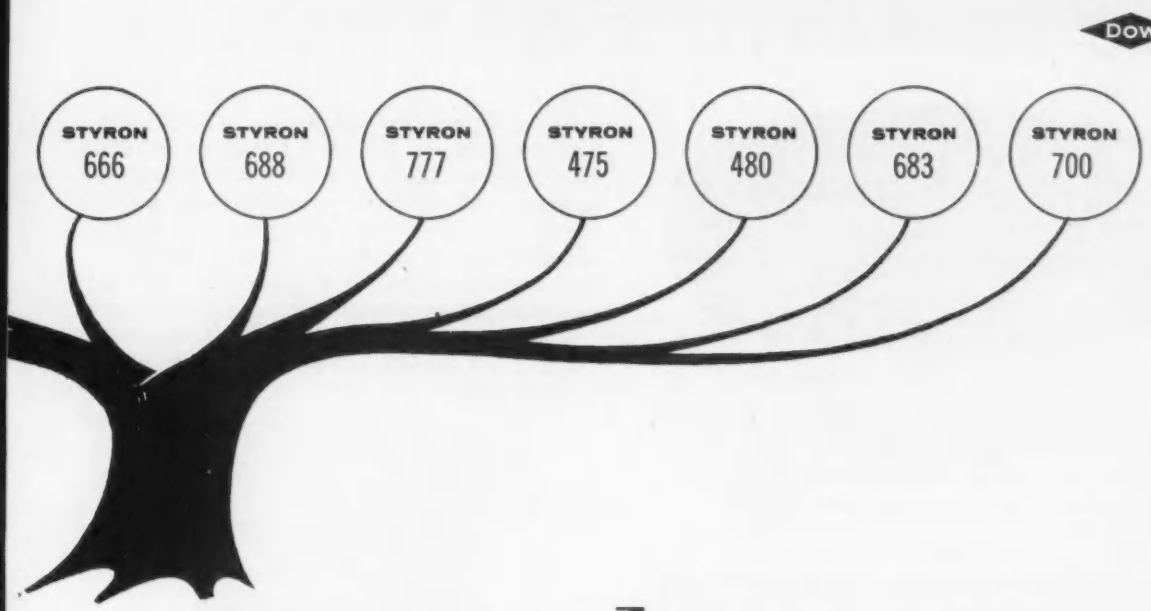
Gives greatly improved surface finish and gloss to sheet products. This combination meets the exacting requirements of the industry . . . increased flexural strength brings new benefits to low-cost vacuum forming from thin extruded sheets.

STYRON 665

general purpose— for improved extrusion

Provides a new standard for quality performance. Greater resistance to shattering and cracking at the cut-off operation. Relatively high heat distortion temperature. For bristles, thin film and many general shape extrusion applications.

Get full details on the Dow polystyrene family at the Plastic Exposition —Booths 1017 and 1025, Coliseum, New York, June 11-15.



compounds

for plastics design and molding

STYRON 689

general purpose—
easy flowing
for thin sections

Meets the special requirements for molding thin sections, deep draws, and parts demanding accurate dimensional control—such as containers, vials and housewares. Proved excellent for high speed automatic molding and large area parts.

Now the growing family tree of Dow polystyrenes gives you your pick of America's most widely used molded plastics. You have new general purpose Styron® plastic materials with improved flow and extrusion properties. You also have new high impact materials with better heat resistance and glossier surface. As a result, you will find many applications are possible for the first time.

Each new compound has been made to the same high standards of quality and uniformity which have earned for Styron plastics an unparalleled position of leadership. And each formulation is proved to do its job—in laboratories, in fabricating and in use by the consumers. Each is proved to be a real champion in its field.

With the addition of these new compounds, Styron brings you eleven different formulations—more than are offered by any other supplier. It is the first and most complete line of polystyrene ever offered. When you call Dow, you know you will find the right polystyrene to suit every molding need.

Consult your Dow representative. Learn about the extra benefits you get with the complete Dow line of polystyrene. Discover the Dow reputation for service including the unique plastics technical service. Write THE DOW CHEMICAL COMPANY, Midland, Michigan—Plastics Sales Department PL427G.

you can depend on DOW PLASTICS DOW

AUTOMATIC CONTROL OF

• A REEVES engineering report on a new control that completely automates mechanical variable speed . . . accurately controls and integrates processing variables

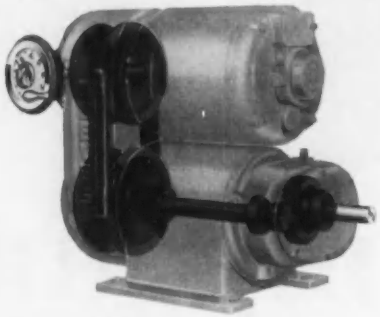
New Control Demands

Recently, with the intensified interest in automating production and processing lines, there developed many new measuring instruments whose signals had to be translated into automatic control of variable speed drives. These signals reflected changes in many variables—such as pressure, flow, weight, level, color, light intensity, radio-activity and peripheral speed.

The instrumentation industry has been ingenious in developing devices to sense and measure these variables, translating them into the industry standard of 3 to 15 psi air pressure; each equal increment of change in psi representing a linear change in the measured signal.

The need, then, has been for some type of automatic control to accurately and continuously transfer the instrument air signal to equally proportioned changes in the output speed of the variable speed drive.

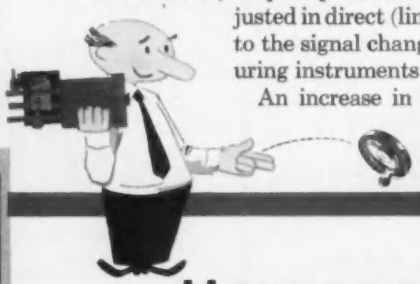
The most logical choice for the basic mechanical variable speed drive is the versatile and efficient REEVES Motodrive . . . an inexpensive power package that combines the motor, variable speed mechanism and gear head reducer into one compact unit. The Motodrive operates on the time-tested principle of a V-belt driving between two pairs of cone-shaped discs which are adjustable to form an infinite number of driving and driven pitch diameters to give variable speed at the output shaft.

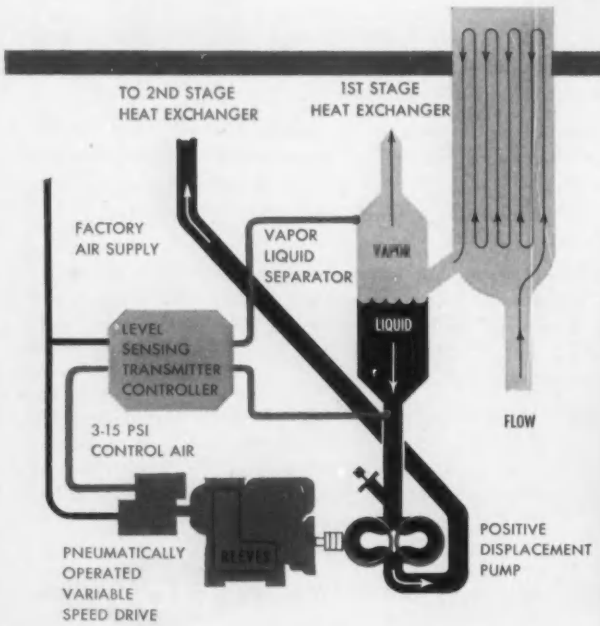


Reeves Automatic Control

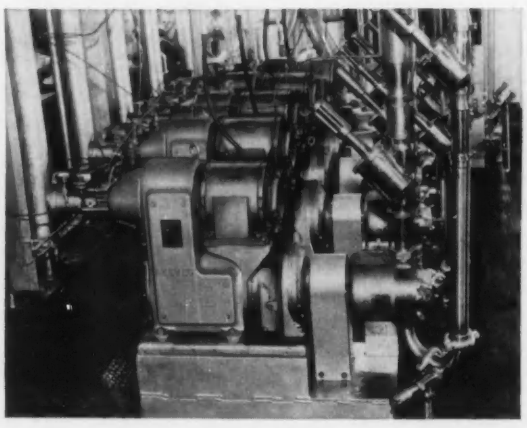
By replacing the manual "handwheel control" of the Motodrive with a pneumatic REEVES Automatic Control, output speeds are continually adjusted in direct (linear) proportion to the signal changes of the measuring instruments.

An increase in the instrument





How one plant

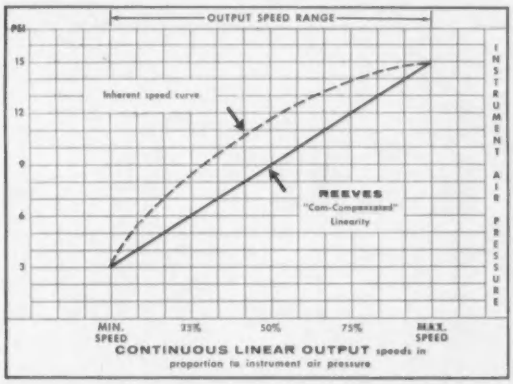


VARIABLE SPEED DRIVES

control pressure activates a valve, admitting supply air to a cylinder chamber. This force against the air piston in the cylinder moves the speed shifting mechanism of the REEVES Motodrive to increase the output speed.

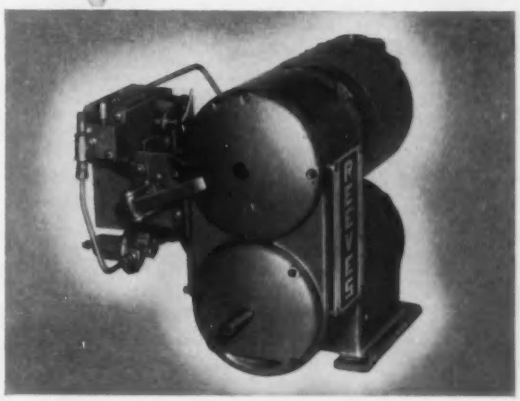
A decrease in control pressure exhausts air from the cylinder chamber, causing a decrease of the output speed. Any change, therefore, in control pressure of the measuring instrument gives an automatic corresponding change in the output speed of the REEVES Motodrive . . . resulting in exact processing control.

Cam-Compensated Design



The output speed of this type of variable speed drive with standard controls is in the form of a curve.

The REEVES Automatic Motodrive incorporates a cam to control output speeds in direct (straight line) proportion to instrument air signal variations. This cam is contoured to produce linear speed changes over the entire output speed range of the Motodrive.



utilizes this Reeves Control

Evaporating the natural waters from fruits to produce fruit concentrates has greatly reduced the cost of packing and shipping of fruits.

Great care must be exercised in the exposure of the fruit pulp to temperature and pressure to retain the natural flavor.

A recently designed and remarkably fast one-pass process incorporates REEVES Automatic Motodrives to automatically control the critical relation between concentrate density and rate of flow.

As water is evaporated from the fruit pulp, the smaller volume reflected by the dropping level in the liquid-vapor separator is sensed by a pressure differential transmitter.

Converted to 3-15 psi air, this signal works through the automatic controller to reduce the speed of the REEVES Motodrive and, in turn, the speed of the constant displacement discharge pump.

The REEVES Automatic Motodrive, used in connection with modern instrumentation, is your answer to flexible, sensitive, accurate speed control for automatic processes.

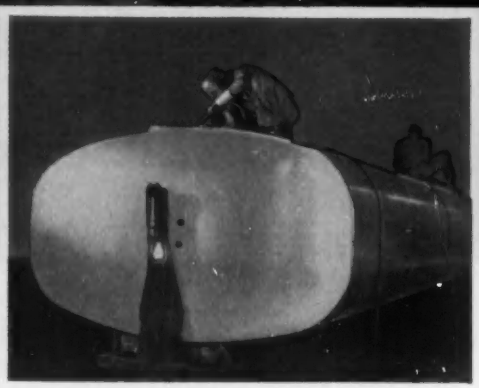
We don't know *all* the possible applications for this control . . . but our engineers will be glad to work with you on *your* design problems.

For more details, write for Bulletin K25-M542.

REEVES DIVISION • COLUMBUS, INDIANA
RELIANCE ELECTRIC AND ENGINEERING CO.

ENDURO STAINLESS

used for safety and corrosion-resistance



Above, refueling the Viscount at Cleveland Hopkins Airport. At left, a stainless steel filler neck is welded to stainless steel section of the tank at Wilco, Inc., Kenton, Ohio and Shelbyville, Tennessee. There's no weakness here. The welded seams will last as long as the walls themselves.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

STEEL . . .

in refueling the Viscount

A unique tank truck, used in refueling Capital Airlines' new Viscount—the world's first turbo-prop airliner—has been developed by Shell Oil Company and built by Wilco, Inc.

The tank consists of two separate compartments. One containing Shell Fuel is fabricated from Republic 50 High Strength Steel for lightness and strength. The other is fabricated from Republic ENDURO Stainless Steel, Type 302, to resist the corrosive effect of the alcohol-water mixture. The two compartments are then welded together into one strong, integral unit.

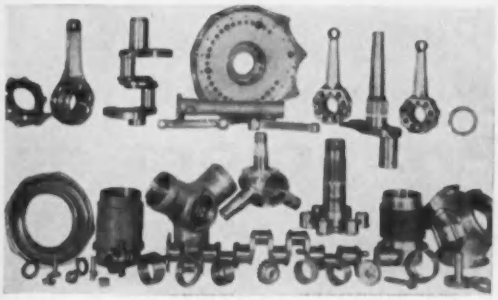
ENDURO Stainless Steel has literally thousands of both ground and air applications. And it is economical to use because it does so many jobs so well at the lowest ultimate cost.

You can use ENDURO in thinner, lighter sections to save weight or gain space without loss of strength, without sacrifice of safety. ENDURO's exceptionally high strength-to-weight ratio and fatigue-resistance provide these bonus benefits.

ENDURO has proved its ability to resist heat in countless applications including compressors, turbines, after-burners, fire-walls and shrouding. Now it is replacing other metals that cannot retain their strength at the high temperatures produced by air friction at supersonic speeds.

Republic is the world's largest producer of aircraft steels—stainless steel, alloy steel and titanium. Our metallurgists and engineers are ready to help you apply them to your design or development work. Just send the coupon for more information.

OTHER REPUBLIC PRODUCTS FOR DESIGNERS AND EQUIPMENT BUILDERS



ALLOY STEELS are exceptionally strong. Their high strength-to-weight ratio permits smaller sections to carry heavier loads at higher speeds with no sacrifice in strength or safety. These fine steels lengthen service life in all types of parts and equipment. Republic metallurgists will help you use these steels to the best advantage.

TITANIUM can save hundreds of pounds per application. Its lightweight and high strength factors plus an outstanding resistance to corrosion make it an extremely attractive metal for use in nacelle construction, firewalls, frames, etc. Republic produces titanium and titanium alloys in hot rolled and cold drawn bars, sheets, plates and billets.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-1503A
3150 East 45th Street
Cleveland 27, Ohio

Please send more information on:
☐ ENDURO® Stainless Steels ☐ Alloy Steels ☐ Titanium

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Westinghouse Protects Its Quality with KLIXON Motor Protectors

Westinghouse, one of the world's leading manufacturers of motors and electrical products, has long been known for quality. And to further assure the utmost in dependability and trouble-free operation of its fractional H.P. motors, they incorporate a built-in Klixon Protector in their Thermoguard* motors.

Here's what Mr. J. F. Farrell, Sales Manager, Industrial Motor Department, has to say about Klixon Motor Protectors:

"Modern living has promoted a multitude of uses for fractional horsepower electric motors. Many of these motors are hidden from view and are relatively inaccessible. They must give dependable automatic service under all operating conditions. The Klixon Motor Protector, used on Westinghouse Thermoguard* protected motors gives this full automatic protection against all conditions that might cause motor overheating".

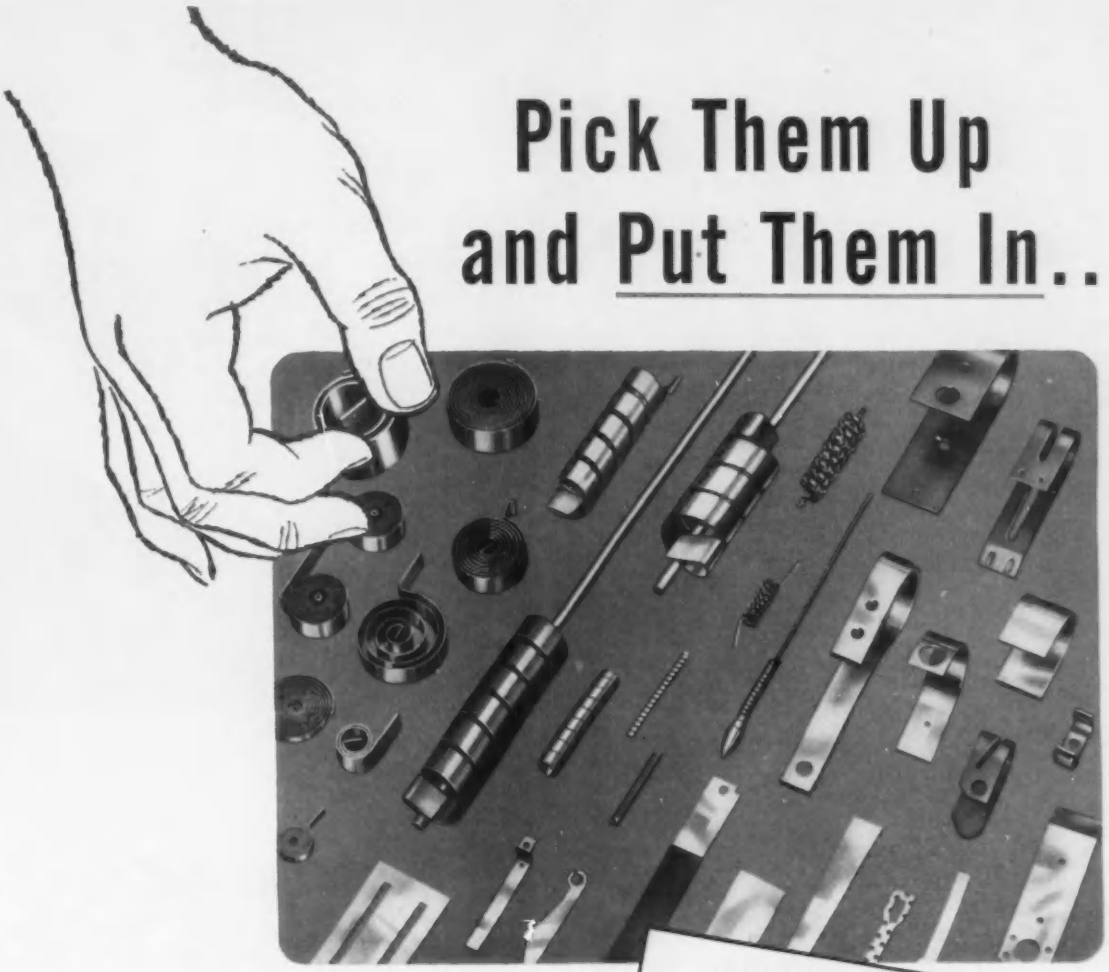
You, too, can keep motors in your equipment working dependably by specifying and using Klixon protected motors. They will reduce maintenance costs, service calls and repairs and replacements. The additional cost is low. The benefits are exceptionally worthwhile.

*Thermoguard is the Registered Trademark of Westinghouse Electric Corporation

KLIXON®

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
906 FOREST STREET, ATTLEBORO, MASS.

Pick Them Up and Put Them In...



Yes — it can be that simple when you use TRUFLEX Thermostat Metal elements and assemblies.

Give us the specifications you want to work to, and we'll make TRUFLEX Thermostat Metal parts that are really at home in your product.

Or, if you prefer to make your own thermal elements, General Plate will produce TRUFLEX in strip form to accurately meet your thermostat metal specifications. Either way you will find that General Plate TRUFLEX Thermostat Metal brings about worthwhile savings in production costs by reducing assembly problems in your products. You get consistently accurate performance of parts or strip because every order comes to you an exact duplicate of the original.

And remember — over forty different types of TRUFLEX Thermostat Metal are available to you — types covering a wide range of temperature extremes for thermostat applications — for immersion in water or steam without corrosion problems — in preferred resistance series to simplify calibrations of current operated devices — for needed spring characteristics in thermal latches — or what have you? Write for TRUFLEX Thermostat Metal Catalog and engineering assistance.

GENERAL PLATE

TRUFLEX®

THERMOSTAT METALS

Fit Into Your Product Picture

with economy, uniformity, and outstanding performance

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION

13 FOREST STREET, ATTLEBORO, MASSACHUSETTS

THIS IS CYPAK

to eliminate maintenance on industrial control

Now you can break the downtime barrier to further expanding industrial control. Westinghouse CYPAK* provides two bold, new advantages to jump the limitations of mechanical relays.

First, unlike the mechanical relay, CYPAK has no moving parts to wear, corrode, jam or otherwise cause failure. Data processing is carried out by magnetic "make and break" of currents giving CYPAK a life at least 15 times that of conventional relay systems.

Second, CYPAK is given greater protection against the mechanical shocks and corrosive elements of industrial applications. Each component panel is sealed in a solid block of plastic. CYPAK systems are built up from an enclosed power channel into which the CYPAK elements are *plugged in, locked in* securely. Signal terminals are joined with push-on sleeve connectors.

But get all the facts on the challenging advances made in CYPAK. Call your Westinghouse sales engineer today.

J-01004

Write today for your free copy. *The Whys and Wherefores of* CYPAK, Booklet B-6584. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Penna.

*Trade-Mark

WATCH WESTINGHOUSE

WHERE THE FUTURE IS ALREADY IN PRODUCTION!

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living ... through Chemistry

PRODUCT ENGINEERING NEWS

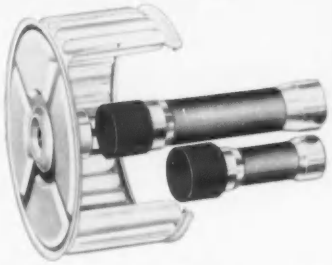
PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 5, 1956

Tough, flexible hose of Du Pont TEFLON® withstands temperatures up to 450°F... is inert to corrosive fluids

Splined sleeve for new flexible coupling molded of tough ZYTEL® nylon resin

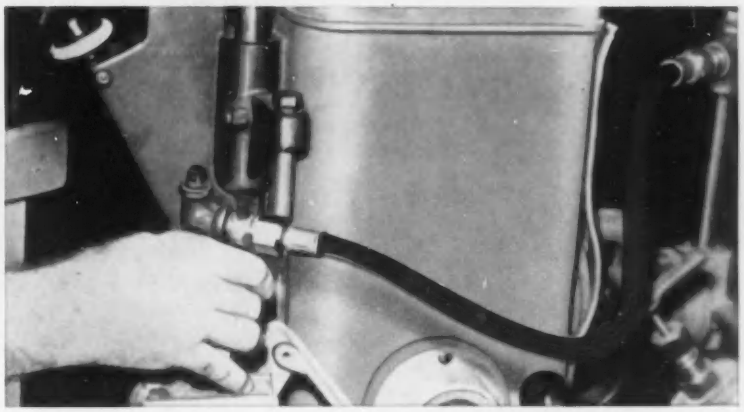
Now, molded ZYTEL nylon resin, with its outstanding wear resistance, toughness, strength in thin sections and freedom from need of lubrication, brings improved performance to this oil burner drive. A splined sleeve of ZYTEL offers continuous high-slip, lateral motion, and low-friction surface which will not gall on the blower wheel hub.



Blower wheel to which flexible couplings attach in gun-type oil burners. Also pictured are two coupling sizes with new splined sleeve of ZYTEL indicated in red. (Manufactured by Guardian Products Corporation, Coupling Division, Michigan City, Indiana.)

Du Pont ZYTEL replaces the aluminum drawn tubing which was previously standard in this application. The ability of ZYTEL to be molded to close tolerances enables the sleeve to offer tight, minimum-diameter clearances. Also, ZYTEL is impervious to fuel oils and stable at elevated temperatures. It offers silent, smooth operation for many years of trouble-free service.

From the initial molding process to the installation of the coupling, ZYTEL offers cost savings to both manufacturer and users. ZYTEL is easily and inexpensively injection molded and requires no further finishing. Installation and downtime are considerably reduced. Perhaps your product could be improved with a proper application of Du Pont ZYTEL. For further property data and application information, clip and mail the coupon on the other side of this page.



After three years' use, this hose lined with Du Pont TEFLON is unaffected by the adhesives it handles, despite constant flexing. (Manufactured by Resistoflex Corporation, Roseland, New Jersey.)

INDUSTRIAL hose lined with TEFLON tetrafluoroethylene resin offers longer service life and an increased range in applications involving extreme temperatures and pressures. TEFLON replaces natural or synthetic rubber linings and is the answer to the problem of conveying adhesives or corrosives.

The Compo Shoe Machinery Corporation, Boston, Massachusetts, is a leading producer of shoe machines and adhesives. In their machines for cementing shoe soles and bottoms, they employ a flexible hose to transmit adhesives from the storage pot to the nozzle. They formerly used hose lined with synthetic rubber. It lasted no longer than a year. They then switched to hose of TEFLON, and users report that the hose is virtually "as good as new" . . . even after three years' use.

Cross section of Resistoflex hose lined with TEFLON and jacketed with stainless steel wire braid. Hose is reported to have practically unlimited shelf and service life.

The list of applications for hose of TEFLON is ever-increasing. Hose made of TEFLON is now standard equipment for hydraulic and fuel lines in jet aircraft, where the flow of corrosive synthetic fuels at high temperatures demands hose material that is rugged and flexible. It is used to convey steam (at 340°F.) under pressures of 170 psi, in a plastic molding application where it is subject to constant flexing.

TEFLON is inert to all chemicals except alkali metals and fluorine under special conditions. Its working temperature range extends from −450°F. to 500°F. It is strong, flexible and nonflammable. The smooth, wax-like surface of TEFLON prevents even the strongest adhesives from sticking to it.

A proper application of TEFLON can provide cost savings as a result of longer service life, reduced downtime or maintenance time. Its unique physical, electrical and chemical properties make TEFLON adaptable to a wide range of applications. Can you take advantage of the remarkable properties TEFLON has to offer? For a comprehensive report on its properties and proven applications, mail the coupon on the other side of this page.

OVER

DU PONT

Reg. U. S. Pat. Off.

Better Things for Better Living Through Chemistry

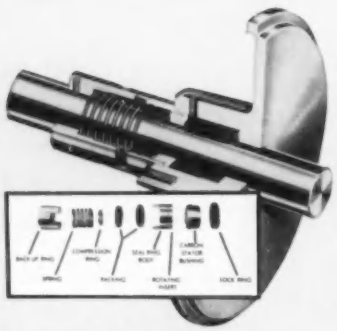
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

TEFLON® simplifies design and reduces costs in mechanical seals

LATEST design in mechanical seals features complete and rapid interchangeability with packing. Developed by Chemical and Power Products, Inc., New York City, this new seal can be made to fit any stuffing box, requiring no alterations or special clamps. It offers economy by eliminating product loss and minimizing installation and downtime.

TEFLON tetrafluoroethylene resin plays the feature role in the sealing of corrosive liquids and slurries. TEFLON is used as a shaft packing in the form of a male and female cup, providing maximum flexibility with minimum spring pressure as a wedgelock in the bottom of the seal to prevent leakage and stop rotation of the stator. The self-aligning wedgelock of TEFLON slips easily in place, and the time and expense involved in installing a clamp to hold the stator are eliminated.



TEFLON is selected in many sealing applications because of its superior physical and chemical properties. TEFLON is chemically inert, and will operate within extreme service temperatures ranging from −450°F. to 500°F. It is nonflammable, has zero water absorption, has low-temperature toughness and a low coefficient of friction.

A proper application of TEFLON can help you solve design problems involving extreme heat or corrosion.

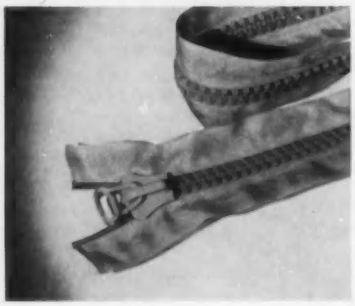
New valve housing economically molded of Du Pont ZYTEL® nylon resin

Illustration shows design change in thermostatically operated water control unit in past sixteen years. A housing of ZYTEL has replaced brass in this modern automatic home washing machine valve. (Housing molded by Chicago Molded Products Corp., Chicago 57, for The Dole Valve Co., Chicago 12, Illinois.)

THE unique properties of ZYTEL nylon resin make it particularly adaptable to this new valve body design. ZYTEL is easily injection molded to close tolerances. ZYTEL is tough, abrasion resistant, strong in thin sections, light in weight and offers good chemical resistance. It provides quiet operation with little or no lubrication, and possesses good insulating characteristics.

The molded threads on the two inlets in the thermostatically operated water control unit pictured above provide a strong, leak-proof connection when used with a standard hose coupling. The resistance of ZYTEL to water and chemicals prevents corrosion. In hard-water areas, these valve bodies are unaffected by deteriorating action of minerals present.

Slide fasteners of ZYTEL have been designed for use in a wide variety of military and consumer goods. Fasteners operate smoothly, even in extremes of temperatures . . . are resistant to mildew, corrosion and chemicals. They can be molded in a broad range of colors. (Manufactured by Waldes Kohinoor, Inc., Long Island City 1, N. Y.)



Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties available with ALATHON® polyethylene resin, LUCITE® acrylic resin, TEFLON® tetrafluoroethylene resin, and ZYTEL® nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 106, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *ZYTEL;* ☐ *ALATHON;* ☐ *TEFLON;* ☐ *LUCITE. I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

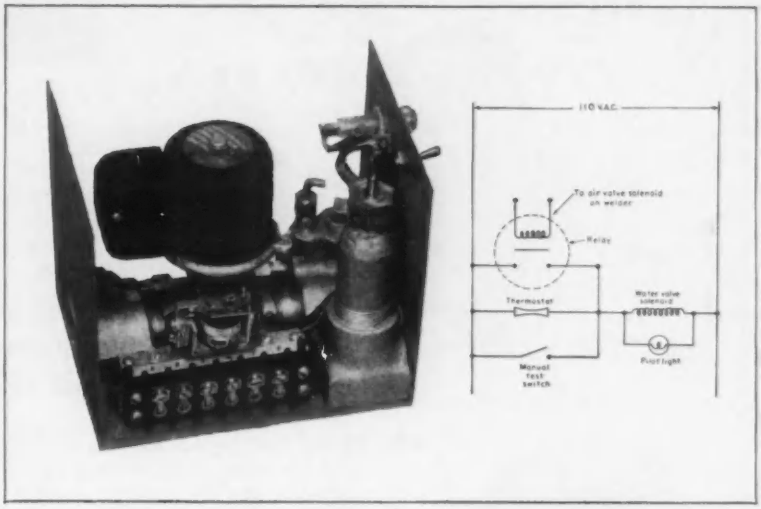
How to Control Cooling Water

No. 5 of a series — *Showing the Broad Application Range of Fenwal Controls*

The Water Mizer is used for resistance welders, induction-heating equipment and hydraulic systems. The unit turns on the cooling water at the initiation of a cycle by means of a relay tied into the operating cycle.

The problem was to stop the water flow to the electrode after the machine is idle for a time long enough to cool the electrodes. Here's how a Fenwal THERMOSWITCH unit solved it —

When the welder is started, the Water Mizer, through a relay control system connected to the air solenoid valve coil or clutch on the welder, releases a full flow of water. The relay control keeps the water valve open until the cooling water becomes warmer than the Fenwal THERMOSWITCH setting, at which time the THERMOSWITCH takes over and controls the flow according to operating requirements.



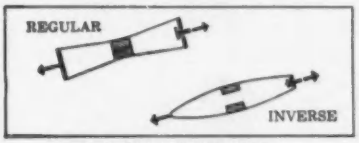
FENWAL THERMOSWITCH unit provides control of cooling water in the Water Mizer, a coolant control for welding and brazing made by Van Vooren Products, East Moline, Illinois. Compact Fenwal units are easily adjustable, highly resistant to shock and vibration and are totally enclosed against dust and dirt.

How Fenwal Thermoswitch Units Operate

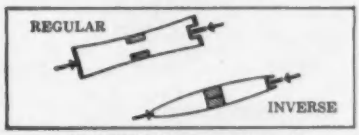
In THERMOSWITCH thermostats the activating *control* element is the metal shell which encases the contact elements. Changes in temperature cause the shell to expand or contract instantaneously. This exerts either tension or compression on the struts, causing the contacts to make or break a circuit. Control in the Fenwal THERMOSWITCH units is calibrated at a given shell temperature by turning the adjusting screw until contacts operate.

Fenwal THERMOSWITCH controls are constructed as either tension or compression operated with regular or inverse contact arrangements.

Tension operated units may be subjected to momentary temperature exposure of 100°F above their set point. They also may be subjected to any temperature below their set point without danger. Tension operated Fenwal THERMOSWITCH units may be set below 0°F but compression operated units are recommended if rapid temperature changes in excess of 100°F or extreme temperature overshoots are to be encountered.



TENSION OPERATED



COMPRESSION OPERATED

Fenwal compression operated units may be exposed to a temperature of −100°F indefinitely, and to temperatures 400°F above their set temperatures for short periods of time.

The Fenwal THERMOSWITCH Control is constructed with two silver contacts mounted on, but electrically insulated from, curved nickel-iron struts of low expansion coefficient. This element assembly is then mounted under tension or compression in a seamless drawn brass or stainless steel tube. The amount of tension or compression is variable, depending on the position of the adjusting sleeve and the temperature of the shell.

Proved Applications

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers.

Write for new Catalog No. 500 for details and complete product listings on Fenwal THERMOSWITCH Thermal Controls, including units discussed above, Midget and Miniature versions of these, Snap-Action Controls, and Indicating Controllers.

FENWAL INCORPORATED
26 Pleasant Street
Ashland, Mass.

Please send me your Catalog No. 500. Our specific problem is: .....

Name ..... *Title* .....

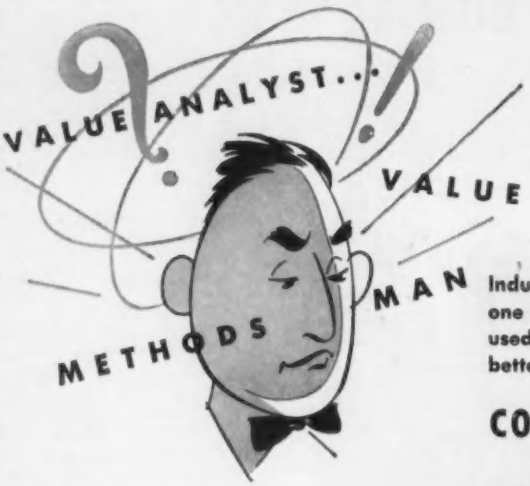
Address .....

City ..... *Zone* .. *State* .....

Fenwal CONTROLS TEMPERATURE . . . *PRECISELY*

THE SURPRISINGLY VERSATILE

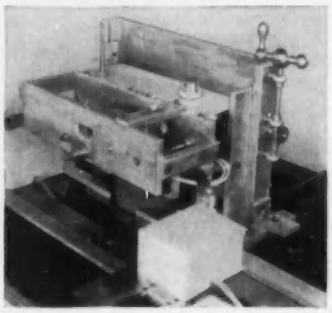
HEIM *Unibal*



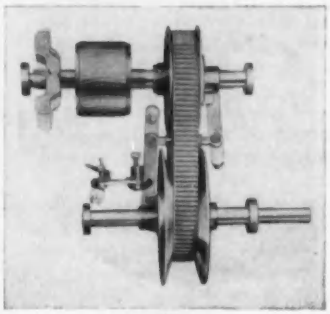
Industry's newest specialist has many names, but just one purpose — to study parts, materials, or methods used in manufacturing, with an eye toward getting better quality or performance at lower cost.

CONSIDER the possibilities of unusual adaptations of the . . . HEIM *Unibal* SPHERICAL BEARING ROD END

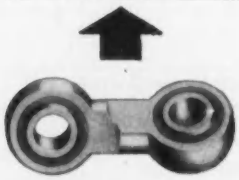
IDEA On the Van Buskirk marking machine, there is a crank, shaft, worm gear, and pinion for raising and lowering printing drums. As an easy-to-install support for this shaft, three Heim Unibal Rod Ends were attached to the frame by simply drilling holes and fastening from the back with ordinary hex-head bolts. While the self-aligning feature of Heim Unibal was not essential at this point, the low cost and simplicity of the mounting made them ideal for these supports.



IDEA Put 2 Heim Unibals in a double-end offset link, such as was done in the Sterling "Speed-Trol" Vertical Mounted electric motor, and you have a smoother operation than could be obtained with specially machined, high cost part and without resorting to weldments or other time- or labor-consuming operations. This double end construction is not a stock item to be sure, but it demonstrates the possibilities of improved operation with the Heim Unibal.



There are no set rules to say that a rod end can only be used as a bearing at the end of a push-pull rod — consider the versatility of the Heim Unibal, whose applications are practically unlimited.



MALE AND FEMALE SIZES ARE LISTED IN THE COMPLETE CATALOG OF HEIM BEARINGS.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

HAS MANY USES OTHER THAN STRICTLY ROD END APPLICATIONS

Designing a new wire product?

Call American Steel & Wire!

Steel wire comes in so many different grades, shapes and finishes that it isn't easy to keep them all at your fingertips.

For this reason, we suggest that you give your American Steel & Wire representative a chance to help with new designs while they are still on the drawing board. He may be able to suggest 1) a more economical wire, 2) a wire that will fabricate more easily or 3) a slight design change that will simplify production or lower the cost of the raw material.

At AS&W, we *use* a lot of wire in our own plants; and have learned many little tricks that are yours for the asking. Just call your American Steel & Wire representative.

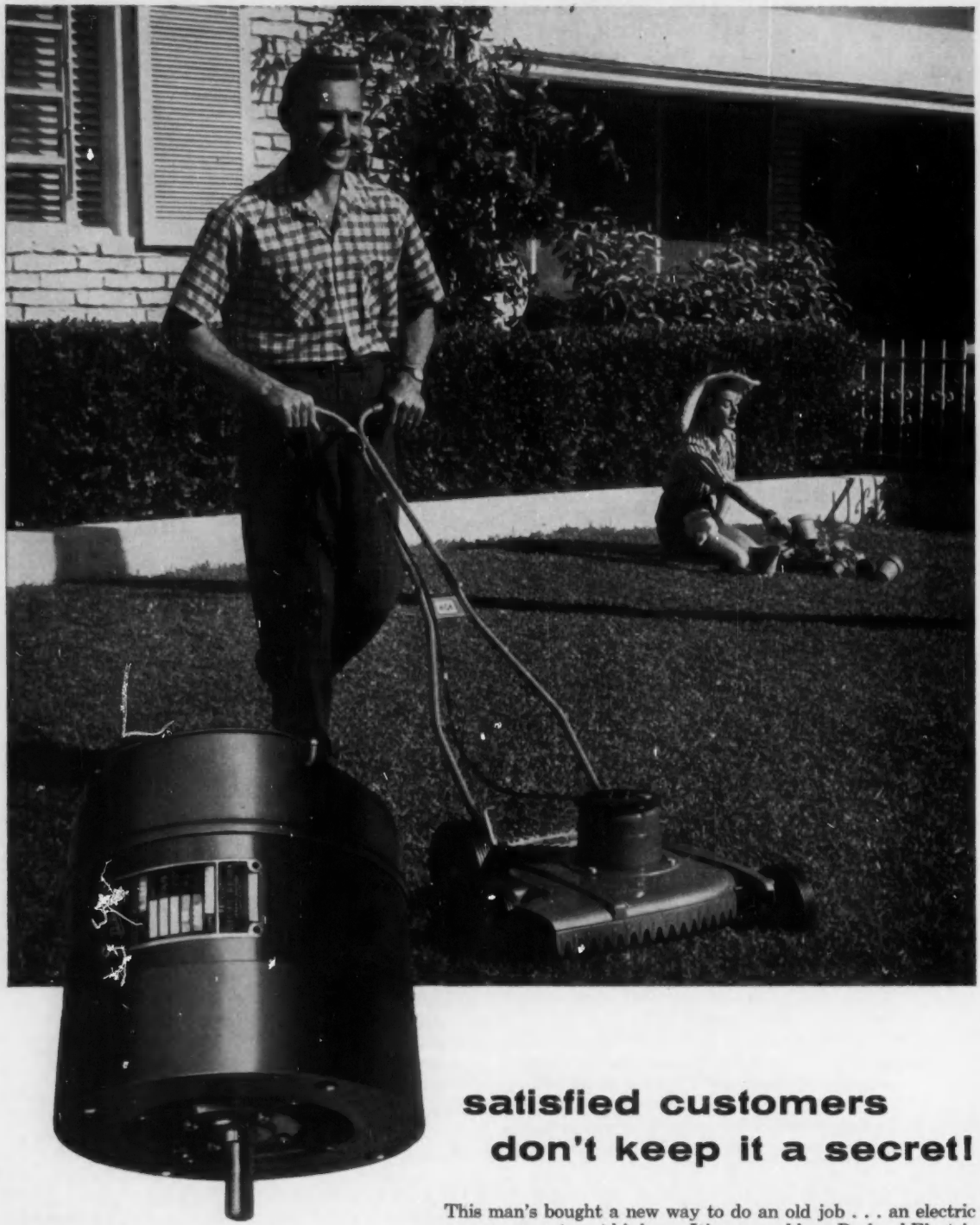
AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN MANUFACTURERS WIRE

USS

AMERFINE—*high quality fine wire.*
AMERSPRING—*music steel spring wire.*
AMERTEMP—*heavy-duty oil-tempered wire.*
AMERLOY—*alloy heading wire.*
AMERHEAD—*uniform heading wire.*
AMERSTITCH—*extra-tough metal stitching wire.*

UNITED STATES STEEL



satisfied customers don't keep it a secret!

This man's bought a new way to do an old job . . . an electric power mower to cut his lawn. It's powered by a Packard Electric motor, in fact, and he's letting his neighbor in on its smooth, quiet, dependable performance. No, there's no secret here. There seldom is when an appliance is Packard-powered!

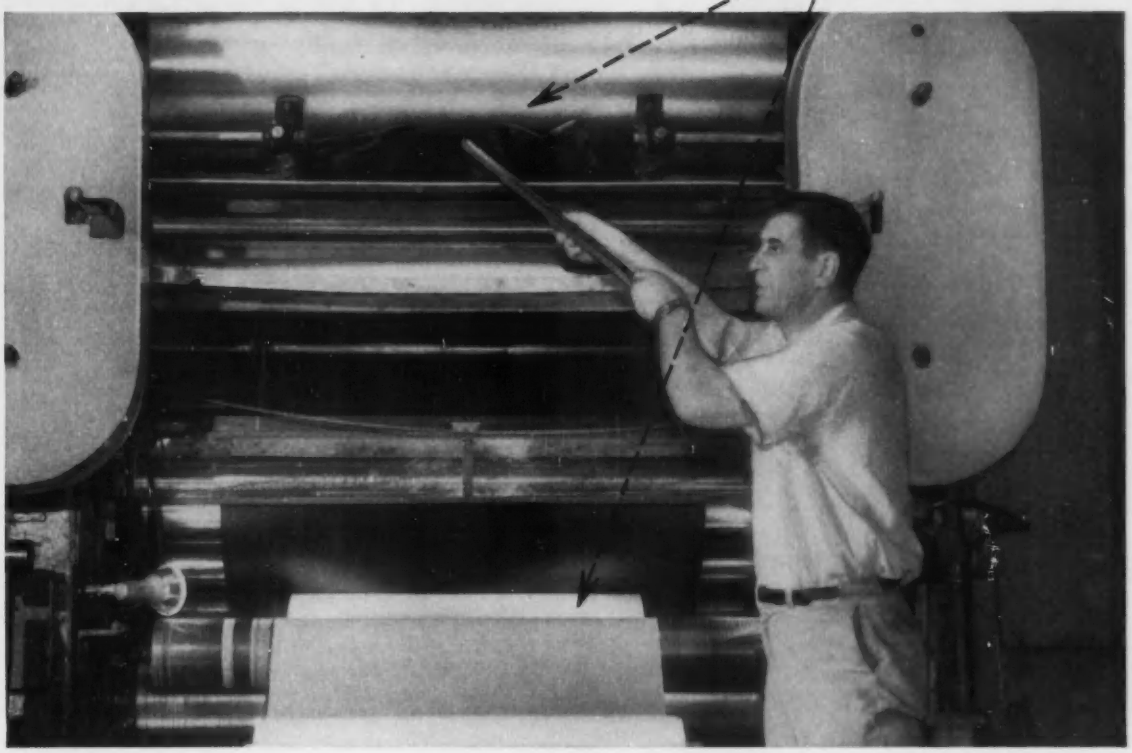
Packard Electric is an old hand at building satisfaction into motors. For over 39 years, Packard fractional horsepower electric motors have been delivering the kind of performance that makes for scenes like this. And scenes like this can't miss building sales and goodwill for appliance manufacturers.

GM GENERAL MOTORS Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors, Warren, Ohio

Maybe your business needs **TWO** miracles



Du Pont puts miracle fabrics and miracle coatings together to serve you better

DU PONT INDUSTRIAL COATED FABRICS

COATING MEDIUMS

Neoprene • Buna-N • Silicone • Polyacrylate
Chlorosulfonated Polyethylene • Tetrafluoroethylene
Butyl • Acrylic • Polyamide
Polyethylene • Polysulfide

SUBSTRATES

Fabrics	Felts or Non-Woven
Cotton • Nylon • "Dacron"*	"Teflon" Felts
"Orlon"** • Asbestos • Glass	Wool Felts
Metal • Rayon • "Teflon"***	

Also elastomer sheet stocks without fabric inserts & cements

*"*Dacron*" is Du Pont's registered trademark for its polyester fiber
**"*Orlon*" is Du Pont's registered trademark for its acrylic fiber
***"*Teflon*" is Du Pont's trademark for its tetrafluoroethylene fiber

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

At the Du Pont Fabrics Division, exceptional coatings are combined with specially selected fabrics—result, a *third* material with the advantages of both. How can you use these miracle *coated fabrics?* Industry is constantly finding applications such as gaskets, seals, diaphragms or protective cloths. The trucking industry, for example, is enthusiastic about nylon fabric coated with neoprene that makes a lightweight, durable tarpaulin.

Perhaps you need a material to withstand gas and oil . . . or to take temperatures up to 450°F? Or do you need a material with good antistick properties? There's almost sure to be a coated fabric just right for the job. If not, the Du Pont Fabrics Division can probably make one that is. We'll be glad to send you further information. Mail the coupon today.

E. I. du Pont de Nemours & Co. (Inc.), Dept. PE-66,
Fabrics Division, Wilmington 98, Delaware

Please send me further information about coated fabrics.

I am interested in using a coated fabric for_____

Name_____ Position_____

Company_____

Address_____

City_____ State_____

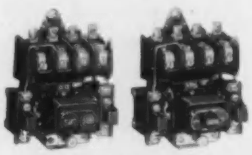
OILTIGHT CONTROL ACCESSORIES
START BUTTON
SELECTOR SWITCH
WING LEVER SELECTOR
COIN SLOT SELECTOR
PILOT LIGHT
Eight button control station built into Cleereman drill press equipped with A-B oiltight buttons. Allen-Bradley also lists a line of surface mounted stations
CLEEREMAN
Cleereman drill press is factory equipped with the special A-B automatic motor control panel shown here, using strictly standard components

FOR DEPENDABLE AUTOMATION • • STANDARDIZE ON ALLEN-BRADLEY CONTROLS

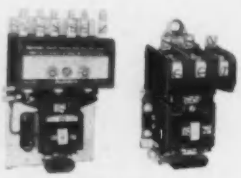
Control panels for an automation line of special machinery must be ultradependable to make the installation a success. The failure of a single item in the control sequence may shut down the entire production line. That is why all electrical and magnetic components must be good for *millions of trouble free operations.*

A-B Quality

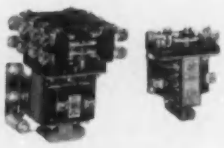
All Allen-Bradley control components, of which a few are shown below, have been time-tested in thousands of industrial applications. They are QUALITY products designed for trouble free service in the toughest automation layouts. Permit us to discuss your control requirements with you. Call on the nearest Allen-Bradley district office.



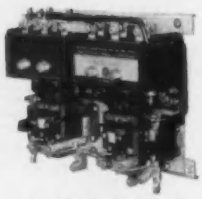
SOLENOID STARTERS
With push buttons • with selector
The Form 2 construction is for remote control



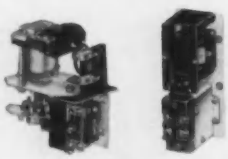
CONTACTORS
From one to eight poles
Ratings up to 1000 amps



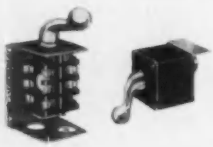
SOLENOID RELAYS
In a wide variety of types



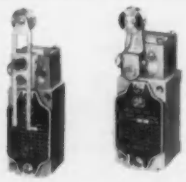
REVERSING STARTERS
Up to 600 hp, 440-550 v



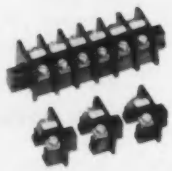
TIMERS
Motor-driven • pneumatic
Other types available



DRUM CONTROLLERS
Up to 500 hp, 440-550 v



OILTIGHT LIMIT SWITCHES
A complete line



TERMINAL BLOCKS
Interlocking to any length

Allen-Bradley Co.
1329 S. First St.
Milwaukee 4, Wis.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

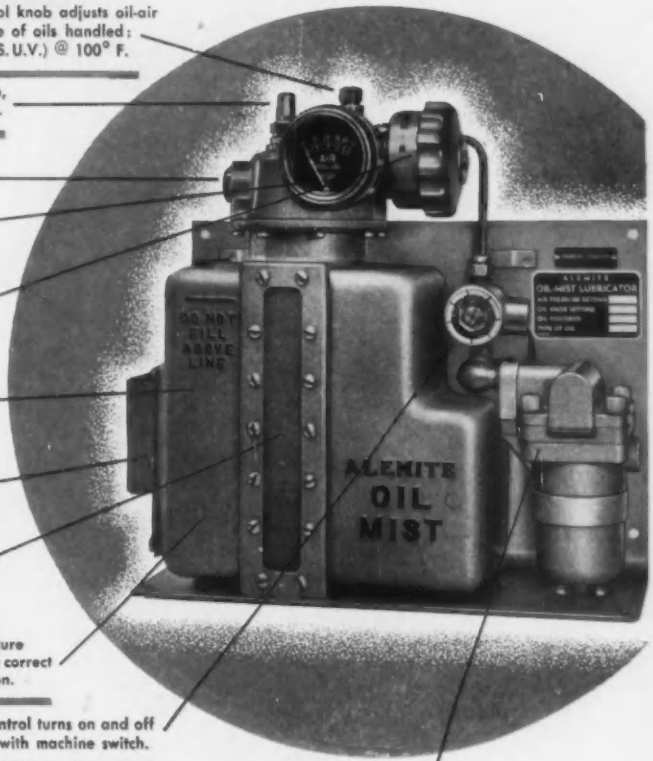
In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

You asked for it!
Designers told us what industry had to have!

ALEMITE OIL-MIST

Proved in countless applications – multiplies bearing life – slashes product spoilage – boosts machine output!

Hundreds of case histories prove savings, ease of installation, increased output with Oil-Mist. And Oil-Mist is simple to design into any machine. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts – vees, chains, slides, gears, all types of bearings. Replaces grease systems. No moving parts – operates on compressed air – completely automatic, fool-proof!



1. Oil flow control knob adjusts oil-air mixture. Range of oils handled: to 1,000 sec. (S.U.V.) @ 100° F.
2. Loader fitting for fast, clean, filtered refilling of reservoir.
3. Oil-Mist delivery outlet for main line leading to bearings.
4. Air gauge registers to 50 psi.
5. Air regulator—operating pressure 5 to 20 psi. Reduces pressures from up to 200 psi. Normal air consumption, .7 to 1.2 cfm.
6. Reservoir capacity one gallon. Also available in 12 oz. size.
7. Low level indicator switch turns on warning signal or stops the machine when oil level is low.
8. Nylon plastic window gives visible check of oil supply.
9. Heater for outdoor or low temperature applications. Thermostat keeps oil at correct temperature for efficient atomization.
10. Solenoid air control turns on and off simultaneously with machine switch.
11. Moisture separator and filter removes up to 98% of moisture from incoming air at flow rate up to 1 cfm.

Complete range of models and multiple unit models to fit any machine – any application

Three types of bearing fittings allow the use of OIL-MIST on any machine!

Oil-Mist fittings bring the most efficient lubrication in the world to any anti-friction bearing—roller, ball, needle.

Spray fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where needed.

Condensing fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rollers.

Alemite Oil-Mist offers these lubrication advantages

Automatic lubrication • Continuous lubrication
Eliminates guesswork • Greater safety • Cuts oil consumption up to 90%
Extends bearing life • Stops oil drippage • Saves man-power
Reduces number of lubricants needed • Eliminates "Down-time"

FREE ... *write today!*

Use coupon below for your free copy of the Oil-Mist catalog and data book!

Alemite, Dept. T-66, 1850 Diversey Parkway, Chicago 14, Illinois

Name .....
Company .....
Address .....
City ..... State .....

ALEMITE OIL-MIST LUBRICATION

A PRODUCT OF SW STEWART WARNER

TOMORROW:

A Standard Motor That Can Live With Water

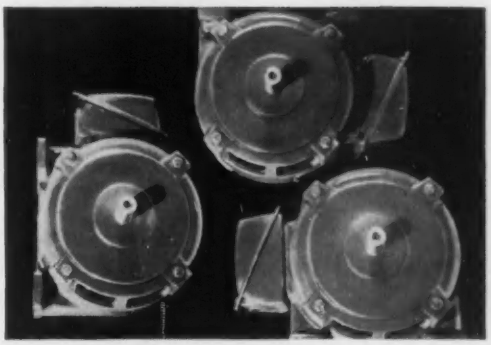
The New Life-Line "A" Is Another Step Closer

Today's standard motors cannot long endure the water conditions shown here. But Westinghouse is working toward a standard motor that can "live" with water like this tomorrow.

Meanwhile improved frame design, insulation and bearing protection give the Life-Line® "A" more protection than ever before. It can withstand more water and other contamination than any other motor you can buy. It's industry's closest approach to a standard motor that can operate with or within water—in any amount.

Your Westinghouse sales engineer can show you many additional reasons why the Life-Line "A" is industry's most advanced and preferred motor. Call him today.

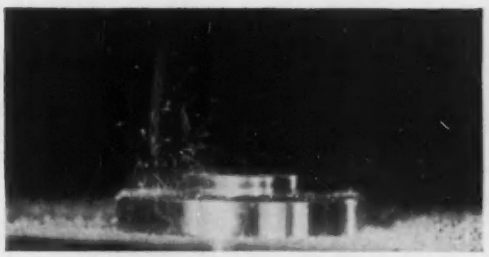
J-21924



New cast-iron frames and brackets utilize the finest grained castings with uniformly thick-walled sections precisely fitted and sealed—another reason why the Life-Line "A" is so preferred.

WATCH WESTINGHOUSE!

WHERE BIG THINGS ARE HAPPENING TODAY!

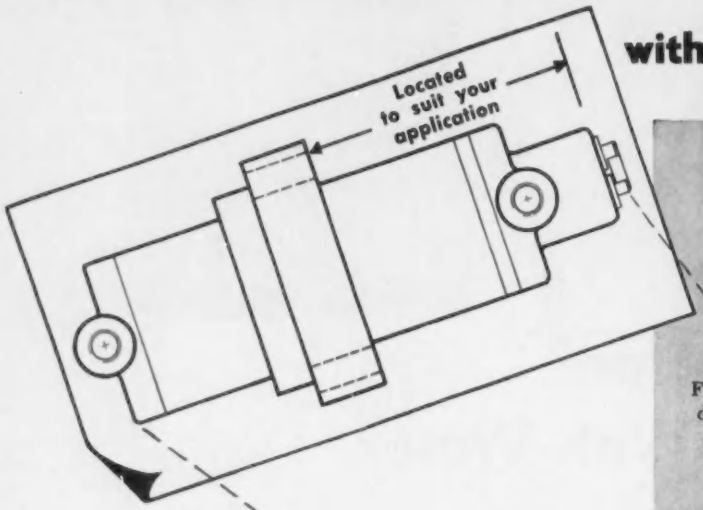


Two outer seals of new 4-way sealed bearing act as flingers and literally throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth.

"We Saved 25% of the Cost of Base Castings"

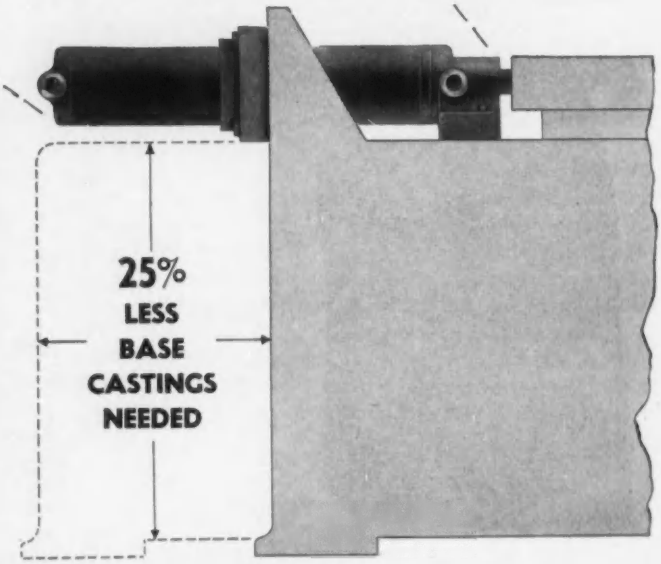
with

Pathon INTERMEDIATE FLANGE MOUNTING HYDRAULIC CYLINDERS



Application of the Pathon Intermediate Flange Mounting, as shown by the simplified drawing below, saved this machine company 25% of their base casting cost. Bonus advantages included reduced shipping weight, easier handling, and the universally recognized operating efficiency inherent in all Pathon Cylinders.

With Pathon Intermediate Flange Mounting Cylinders you choose whichever mounting position best suits your specific needs. Various heads of other mounting types may be combined with the intermediate flange to provide a large number of combination mountings. Thus special mounting brackets are eliminated. The cylinder is rotatable to any position for connecting pipe ports and mounting puds. Pathon Cylinders are available in the R. H. 2000 P.S.I. Series and the Q.H. 1000 P.S.I. Series.



HAVE YOU A HYDRAULIC CYLINDER MOUNTING PROBLEM?

The chances are that one of the standard eight Pathon Hydraulic Cylinder mounting types or their combinations will adequately fill it. However, on any unusual Cylinder problem, we will be glad to help you reach a solution. Don't hesitate to write us.

Pathon MANUFACTURING CO.

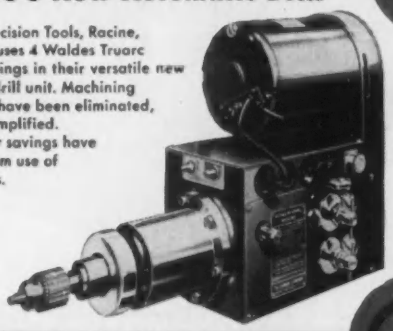
3823 PACIFIC AVE. — CINCINNATI 12, OHIO

AIR CYLINDERS—HYDRAULIC DIRECTIONAL CONTROL VALVES—HYDRAULIC CYLINDERS

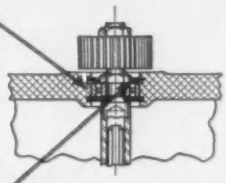
4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

Dumore's New Automatic Drill

Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

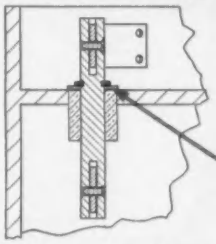


Drive Spindle Assembly



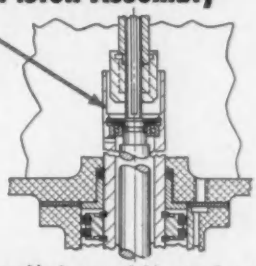
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

Piston Assembly



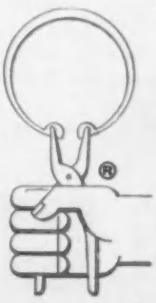
Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!



Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name .....
Title .....
Company .....
Business Address .....
City ..... *Zone* .... *State* .....

PN 668

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

WOULD A TOUGHER STEEL CHANGE YOUR PLANS?

New Lukens "T-1" steel has three times the yield strength of carbon steel—cuts equipment weight, cuts costs!

■ Here's a new alloy steel with unusual resistance to abrasion, impact and atmospheric corrosion . . . that *stays* tough at temperature extremes. And where extra strength is required from plate steel, Lukens "T-1" steel makes possible substantial overall savings in material.

If you plan or purchase bridge parts, construction machinery or any general industrial equipment, check Lukens "T-1" steel now! Its rugged on-the-job performance can reduce maintenance expense and replacement costs—often provide longer service life!

The latest addition to a complete line of carbon, alloy and clad steels, this all-purpose material is obtainable from Lukens in the widest range of plate sizes available anywhere! Whether you want specific product information or the best ways to make the most of it, write to Manager, Marketing Service, 849 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

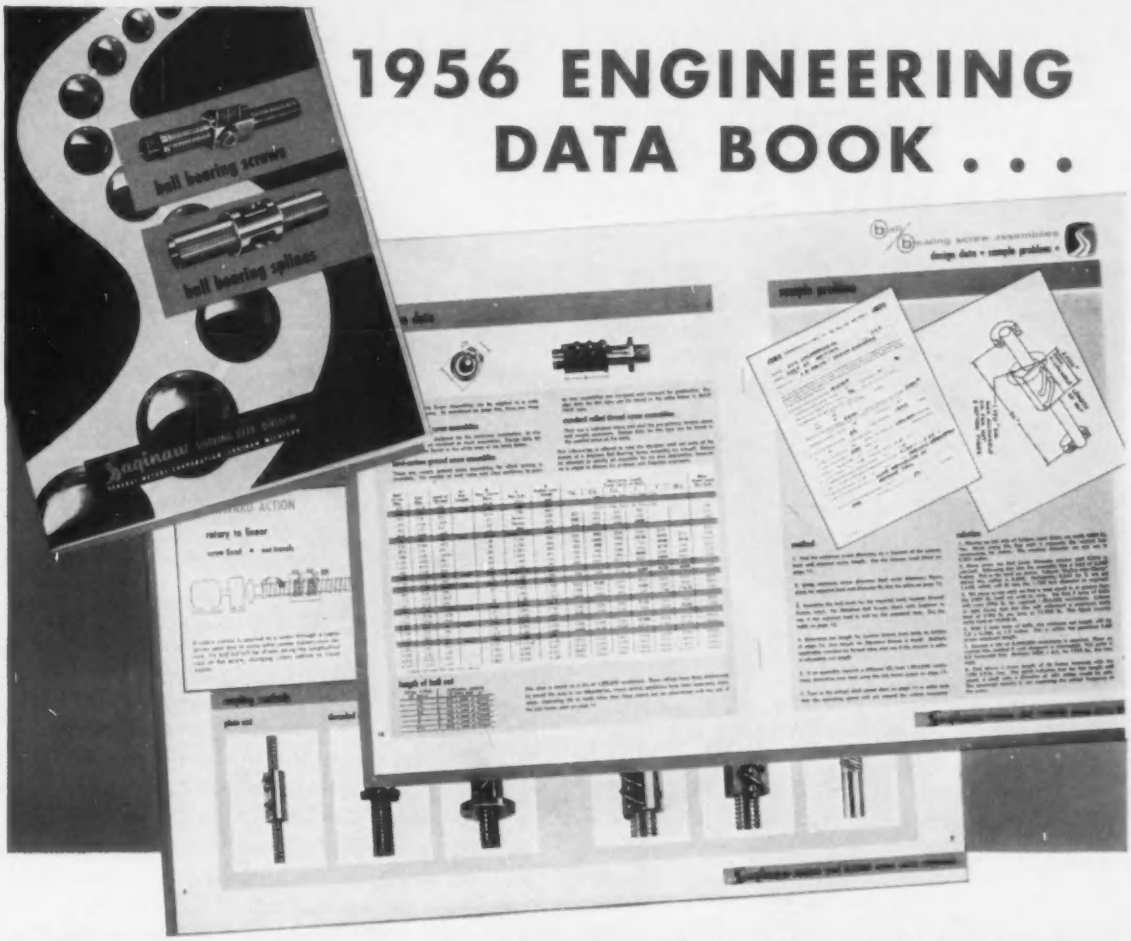
Whatever your plans—now's the time to change to . . .

LUKENS "T-1" STEEL

LUKENS

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS
LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

1956 ENGINEERING DATA BOOK . . .



SHOWS HOW SAGINAW b/b SCREWS and SPLINES FREE YOU FROM DESIGN LIMITATIONS OF ORDINARY ACTUATORS and POSITIONERS

BOOK CONTENTS: Principle • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Charts: Expected Life, Critical Speed, Column Load • Design Data • Sample Problem • Typical Custom Assemblies • Standard Assemblies

SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require 2/3 LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +400° F. Two types: precision-ground or economical rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 9 ft. long.

Saginaw
ball bearing
Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND COUPON FOR 32-PAGE ENGINEERING DATA BOOK

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 6J, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

efficient, long-wearing seals produced at reasonable cost with compatible

GRAPHITAR® *and*

GRAMIX® **PARTS**

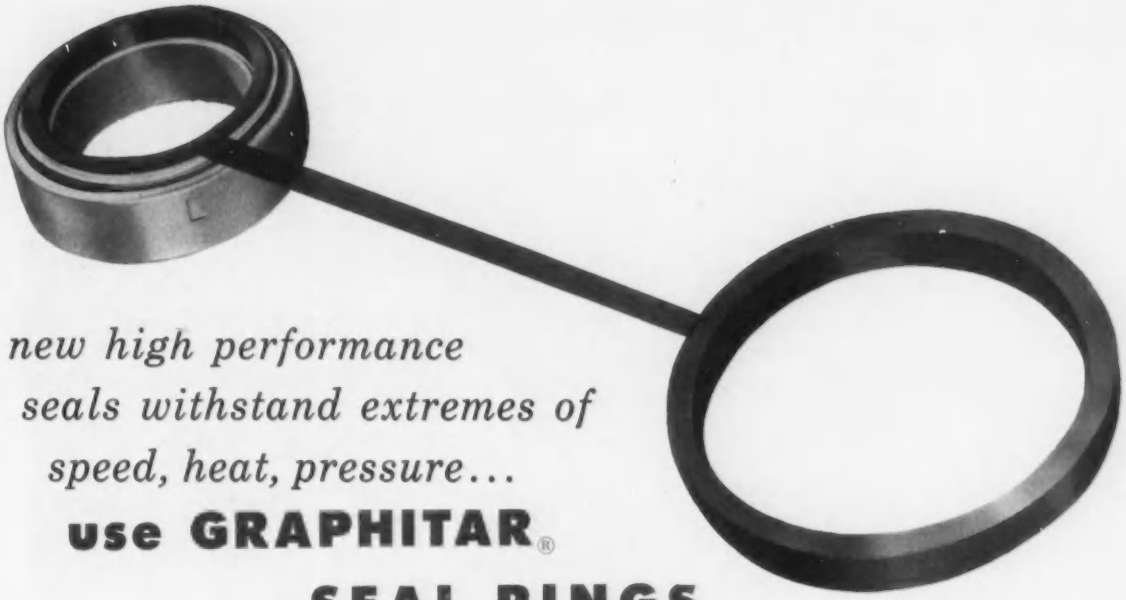
GRAPHITAR is not only a high-quality seal material, but when produced in volume, an economical one as well. In low-pressure applications where mechanical seals have heretofore been too expensive, the Gits Bros. SGU stock shaft seal, using GRAPHITAR wearing and sealing elements, is finding wide use. Cost of the GRAPHITAR seal rings is reasonable enough to make the SGU practical in such high-volume products as washing machines, garbage disposal units, and pumps. Performance is excellent, due to GRAPHITAR'S low friction, high strength, durability, self-lubricating properties and its guaranteed continuing inertness to all known detergents. The long life of the SGU seal is further assured with a GRAMIX Grade 263 nickel-bronze seal-seat. GRAMIX Grade 263 is also corrosion resistant to detergents and the wear and sealing-in characteristics are especially compatible with those of GRAPHITAR. As a result, the Gits SGU shaft seal combines economy with very efficient operation, and is manufactured in standard sizes ¼″ thru 2″ and in shaft increments of ⅛″.

SGU Seal Performance Data:

Speeds.....1750 to 3600 FPM	*Sealed Liquids* Soaps, Greases, Animal Fats, Strong Detergents
Temperatures Continuous.....250°F. Intermittent.....275°F.	*Lubrication* Soaps, Greases, Animal Fats, Strong Detergents and water splash lubrication
Pressures Normal.....10 to 15 psi Maximum.....35 to 40 psi	

THE UNITED STATES

209



new high performance seals withstand extremes of speed, heat, pressure...

use GRAPHITAR® SEAL RINGS

The Gits Bros. style HH stock shaft seal has been designed for use in aircraft accessories and in other equipment where maximum performance is demanded. This seal meets minimal space requirements, and, due to its GRAPHITAR seal ring, can perform under extremes of temperature, pressure, and seal face surface speed. GRAPHITAR, being an inert carbon-graphite material, is relatively unaffected by such extreme operating conditions, and is likewise unaffected by most chemicals or acids . . . even very corrosive ones. GRAPHITAR possesses excellent sealing qualities, a low coefficient of friction, a long wear life, and is in addition self-lubricating. These properties assure the HH seal of efficient operation with a minimum of maintenance . . . very important in such end uses as jet aircraft, reciprocating accessory units, and hydraulic pumps. Gits Bros. manufacture these seals in *standard sizes* ¼" thru 4" and in shaft increments of ¼".

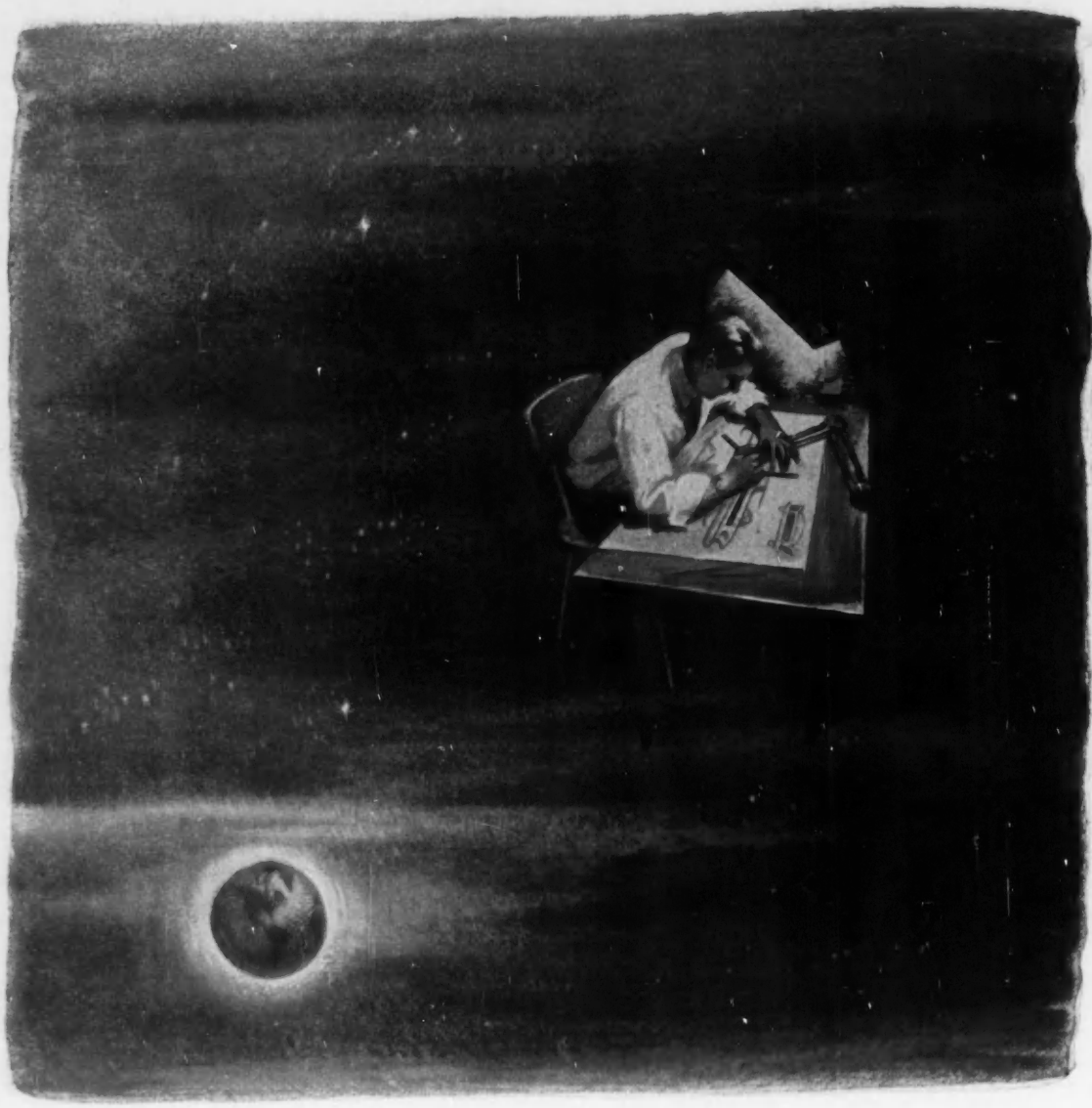
HH SEAL Performance Data:

Speeds.....20,000 feet per min.	*Sealed Liquids* Aircraft fuels and oils
Temperatures.....400°F. maximum	*Lubrication* Mists, vapors, full fluid
Pressures.....1000 psi maximum	

VERSATILE GRAPHITAR seals, bearing, vanes, piston liners, and many other parts show improved characteristics. GRAPHITAR parts are made from carbongraphite powders compacted in dies under great pressure and furnaced at temperatures near 4500°F. They can be relatively complicated in shape, and are ground to tolerances as close as .0005". GRAPHITAR is lightweight, strong, and durable, chemically inert, and virtually unaffected by extremes of speed, pressure, or temperature. It can be operated dry, or where water, steam or another fluid are the only lubricants. Write today for our illustrated 64-page GRAPHITAR catalog.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN



Mr. Designer: Don't give up that bold idea until you talk to "U. S." Molding experts

With U. S. Molded & Engineered Products, designers find they can do things impossible with any other material. Problems in flexing, in product thickness, in uniformity and consistency—*no matter how high your production quota*—all become far easier or disappear entirely. The designer, free of the shackles imposed by other materials, can set his sights for exciting new horizons in design and construction.

"U. S." expertly molds rubber with any or all of these important properties: compression recovery... resistance to acid, various chemicals, oil, water... hot or cold tear-resistance... required tensile strength and elongations.

"U. S." factory-trained engineers will help you solve any molded rubber problem. Contact United States Rubber, Mechanical Goods Division, Rockefeller Center, New York 20, New York.

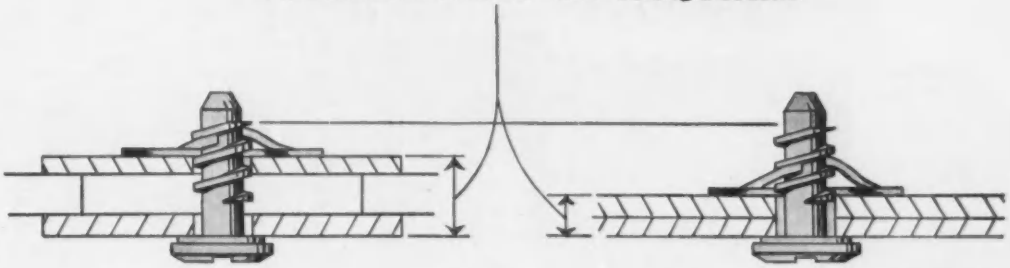
Mechanical Goods Division

United States Rubber

Why change cowl fastener size every time tolerances vary .010" ?

SOUTHCO quick release fasteners provide:

±TOLERANCES AS REQUIRED



Industrial tolerances, provided only by Southco Quick-Release Fasteners, are designed to accommodate variations in thickness normally encountered in metal working. No longer is it necessary to call out a different size precision type fastener because of a few thousandths variation. You eliminate a serious stock problem and reduce assembly time when you specify SOUTHCO.

You can easily choose the right Southco Quick-Release Fastener from a wide variety of stock sizes which include two diameters and three head styles.

The Southco Handbook makes it easy to pick the proper fastener. Write for your copy today. Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

© 1954

SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

SOUTHCO DIVISION
SOUTH CHESTER CORPORATION
236 Industrial Highway, Lester, Pa.

Please send me, without cost, the 24 page SOUTHCO FASTENER HANDBOOK ☐

Please have representative call ☐

NAME _____

POSITION _____

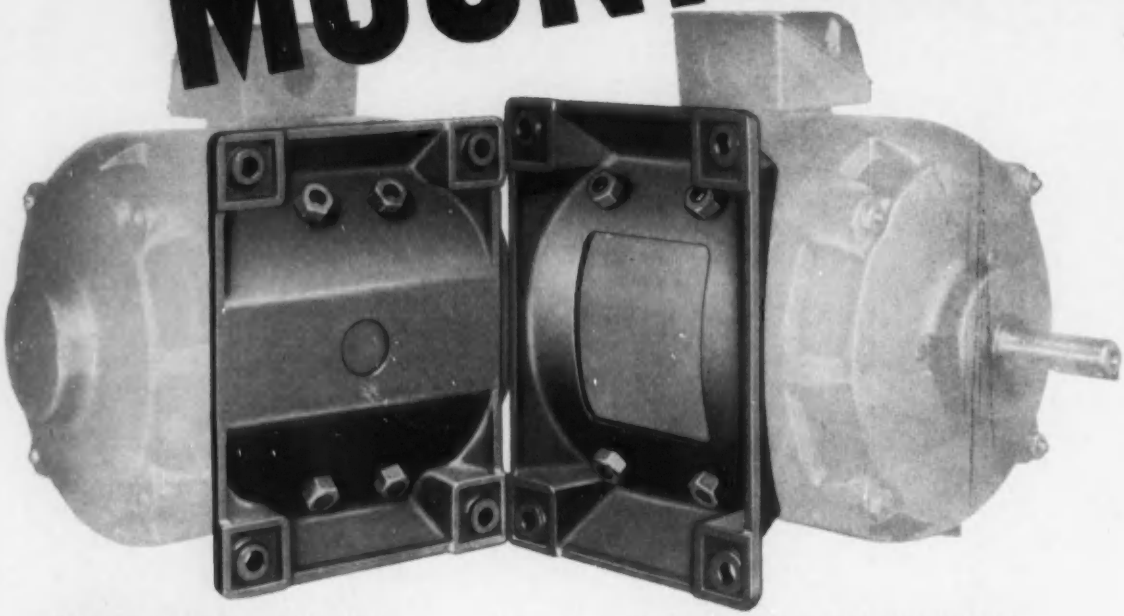
COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Optional FRAME MOUNTINGS

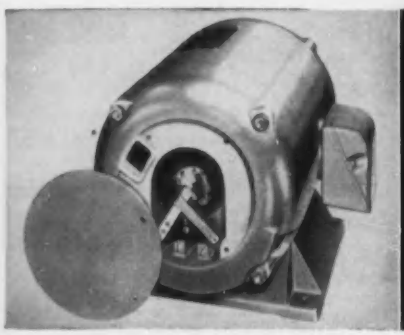
A. O. Smith



Want to use new NEMA mounting dimensions for integral horsepower motors?
Do it with A. O. Smith Integrals! Optional frame mountings fit NEMA sizes 182, 184, 213, 215.

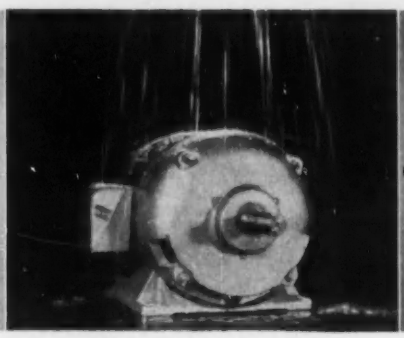
Want to keep old mountings but still enjoy all the advantages of new NEMA ratings?
Do it with A. O. Smith integrals! Optional frame mountings fit old NEMA sizes 203, 204, 224, 225.

You get these quality A. O. Smith motor features...



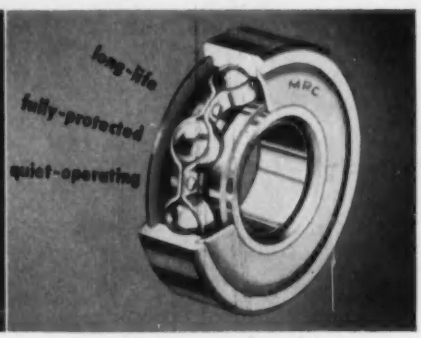
SEALED STARTING SWITCH AND ACTUATOR

Exclusive development... totally-enclosed in end frame. No need to remove motor from line for switch service.



DRIP-PROOF CONSTRUCTION

Motor can be mounted in any position... drip-proof thru 360° cycle... simply rotate end brackets. No foreign matter can enter vent holes.



PRE-LUBRICATED BEARINGS

Shielded bearings assure protection against over greasing... provide even load distribution under all working conditions... quiet operating.

integral hp motors have

frame mountings to *fit your product specifications*...

with either *new* or *old* NEMA dimensions.

THERE's no need to change product design or manufacturing processes to enjoy all the advantages of new NEMA specifications for integral hp motors. A. O. Smith offers you motors with optional frame mountings — either the old specifications or the new.

Optional frame mountings for integral hp motors is one of the features used by A. O. Smith in "Application Engineering" motors to your particular design requirements. There's no need to adapt your product to the design limitations of a conventional motor.

Whatever your speed or design requirements, there's an A. O. Smith integral hp motor available to power your products. Integrals are built in single and polyphase . . . in various speeds and frequencies . . . choice of frame mountings for either old or new NEMA dimensions . . . C and D flanges with special flanges as required . . . 1 thru 150 hp.

Produced by one of America's great industrial concerns, these motors are backed by a national network of 270 strategically located factory service stations.

There's one near you — ready to provide 24-hour action on all parts and service orders.

For more information on A. O. Smith integral hp motors, write for new Bulletin No. EM156.

Through research ... *a better way*

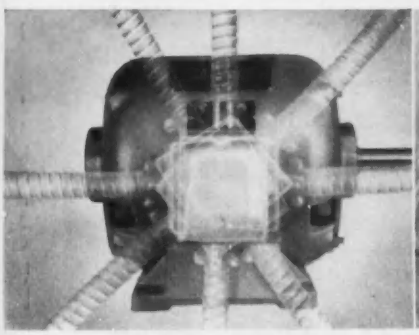
A.O.Smith

CORPORATION

TIPP CITY, OHIO

International Division: Milwaukee 1, Wisconsin

application-engineered to match your product requirements

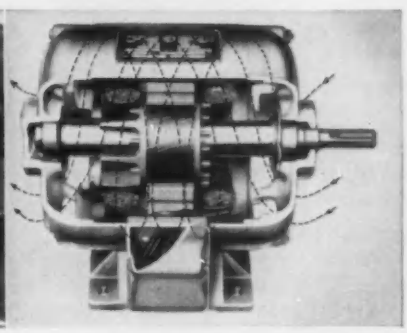


FULL-ROTATING CONDUIT BOX

Can be set at any angle. Designed to save motor space and speed installation. Loosen only three screws to rotate conduit base.

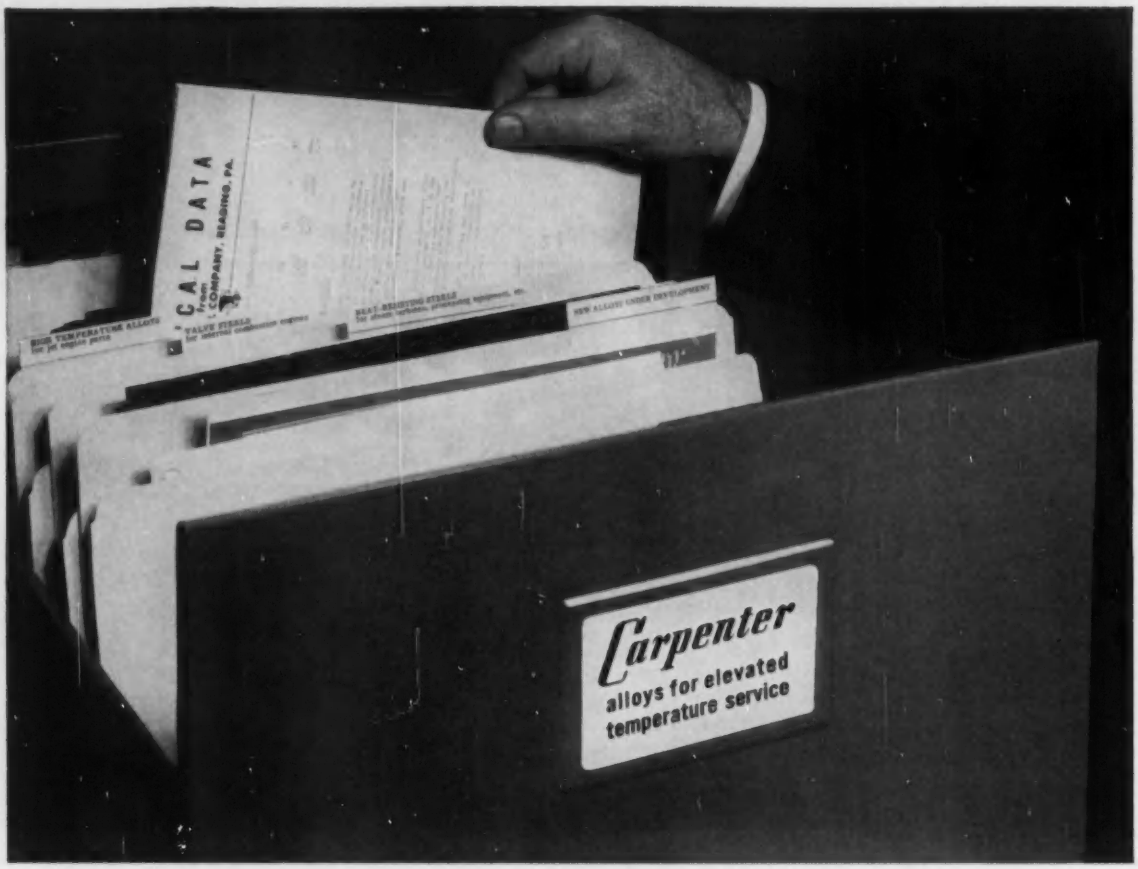
DYNAMICALLY-BALANCED ROTOR

Assures continuous, vibrationless, trouble-free performance and maintains long bearing life. Indestructible laminations are high-quality silicon steel.



CONTROLLED THRU-VENTILATION

Cooling system designed for high-volume, low velocity air for maximum heat transfer. Temperature held to absolute minimum, assuring longer insulation life.



Discover how these ELEVATED TEMPERATURE ALLOYS can give you

√ Improved Forgeability √ Greater Uniformity √ Cleaner Steels

Exciting possibilities for improvement are ahead when you look into the line of Carpenter alloys for parts or products in elevated temperature service. Here is a line of high temperature and heat-resisting alloys produced in a specialty mill. Only a true specialty mill can produce so well these very difficult-to-make alloys.

Here, too, is a combination of unusual advantages not normally found in this type of alloys. For example, Carpenter pioneered the addition of rare earth elements to the analyses of certain grades to give you improved forgeability. And Carpenter's unsurpassed, meticulous quality controls, assure you steels with greater uniformity and extra cleanness to meet the strictest inspection requirements.

Whether you work with one of our present elevated temperature alloys, or a steel produced specifically for your own application, you'll find that Carpenter's wealth of fabricating and working information will help you substantially reduce production costs and get better parts.

Outline your plans or problems to your Carpenter Representative or write direct. You'll get the kind of help that pays off with definite improvements. *The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.*

Specify Carpenter alloys for elevated temperature service and get these three big advantages . . .

Improved Forgeability
Greater Uniformity
Cleaner Steel

Carpenter STEEL

Improved Alloys for Elevated Temperature Service

9 design problems that can be met with the... Allenut

Ever-increasing applications for the new ALLENUT have caused sales to double within the past two years. Here are some of the things it can do to aid your product designing:

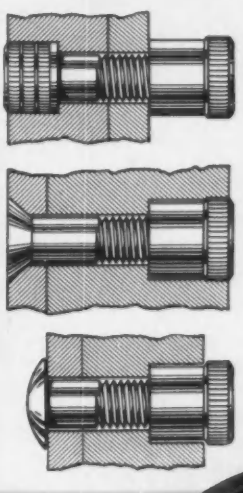
1. *Self-anchoring in any metal.* Allenut provides positive anchoring action through its hardened knurls.

2. *Compact design.* Requires no space for box wrenching. 12-point socket permits tightening in awkward places.

3. *Smooth surfaces.* Fits flush or below surface in counterbored hole . . . permits streamlined, safe surfaces.

4. *A ready-made, hardened, tapped hole.* When used as a bushing, prevents costly stripping of threads caused by frequent removal and replacement of screw or bolt. In castings and other soft metals a stripped hole can be counterbored, an Allenut inserted and the same bolt or screw used.

5. *Tighter fit.* Greater thread contact than with ordinary nuts because of Class 3 fit. Weld-like setups accomplished with one hand wrenching. Allenut holds firm against turn of screw.



6. *Usable with any type of bolt or screw.* Permits space-saving, internal wrenching of cap screws, T bolts, machine bolts, and other common fasteners.

7. *Saves parts.* No washers required when anchored.

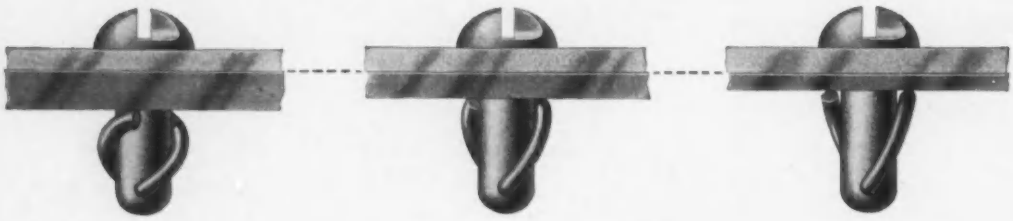
8. *Easier to use.* Knurled ring facilitates fingering-in. Allenut is always square to counterbored hole. Removable by hitting screw or bolt head with tap of a hammer.

9. *Reusable indefinitely.* Anchoring action remains unimpaired. Hardened threads and socket stand up under repeated removal and replacement.

Allenuts are available in a full range of 14 standard sizes from no. 4 to 1" from leading industrial distributors.

We welcome your inquiry and request for engineering details on Allenut applications.

This fastener works through thick and thin!



Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION

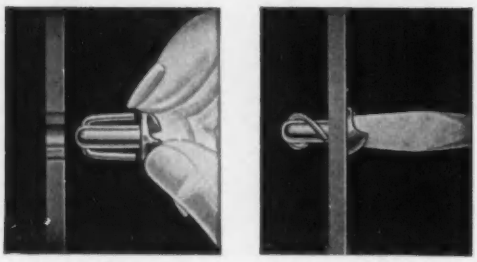
1751 North Broadway, Albany 1, New York

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS



1. *Insert fastener.* **2.** *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

How flange surface conditions affect gasket compression

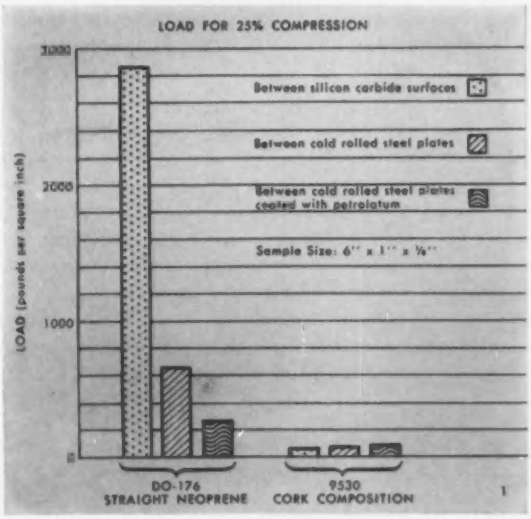
Some manufacturing processes deposit grease or oil on flange surfaces—others leave these surfaces smoothly finished. Naturally, under such varying conditions, certain types of gaskets may show unexpected load-compression characteristics.

Non-compressible rubber materials, for instance, slip badly on greasy or smooth surfaces. Thus grease, cutting oils, or a wet gasket cement can upset load calculations based on dry rubber placed between clean, non-skid plates. Compressible materials, however, are much less affected by slick conditions on flange surfaces.

Figures 1 and 2 show the comparative behavior of four different resilient materials under different surface conditions.

rubber gaskets

The first of these materials, Armstrong DO-176, (Fig. 1) is a straight neoprene compound. It requires a load of over 2,800 psi for 25 per cent compression



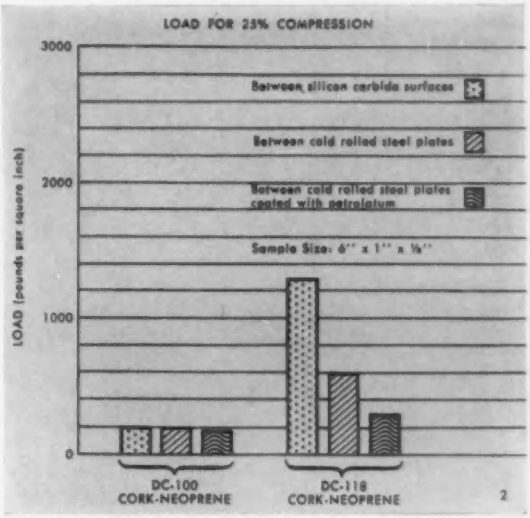
when gripped between rough ceramic surfaces. Between cold rolled steel plates coated with petrolatum, the load required for the same deflection drops below 250 pounds. Even without a lubricant, skid on smooth steel surfaces reduces the load required to slightly more than 600 pounds.

cork composition

With cork composition, a truly compressible material, varying surface conditions have little effect. As shown in Figure 1, Armstrong 9530 Cork Composition compresses 25 per cent with nearly the same load on a greasy surface as on a rough, dry surface. Maximum load variation is only about 3 pounds.

cork-and-rubber

By combining cork and rubber in varying amounts, compositions can be made whose behavior on slick surfaces falls between that of straight cork and that of straight rubber. Armstrong DC-100, for example,



is a neoprene composition with a high cork content. As shown in Figure 2, load for 25 per cent compression on a greasy surface (160 psi) is only slightly less than on a rough surface (200 psi). On plain rolled steel plates, no slippage at all is evident.

Armstrong DC-118 (Fig. 2), on the other hand, contains relatively little cork. Load for 25 per cent compression drops from about 1,300 pounds on rough surfaces to 600 pounds for smooth steel plates. The same plates, coated with petrolatum, further reduce load to about 300 pounds. Other Armstrong cork-and-rubber compounds produce intermediate degrees of compressibility to meet particular needs.

SEND FOR 24-PAGE GASKET DESIGN MANUAL

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy to Armstrong Cork Company, Industrial Division, 7106 Irvin Street, Lancaster, Pennsylvania. For information on all Armstrong Gasket Materials, see Sweet's product design file.

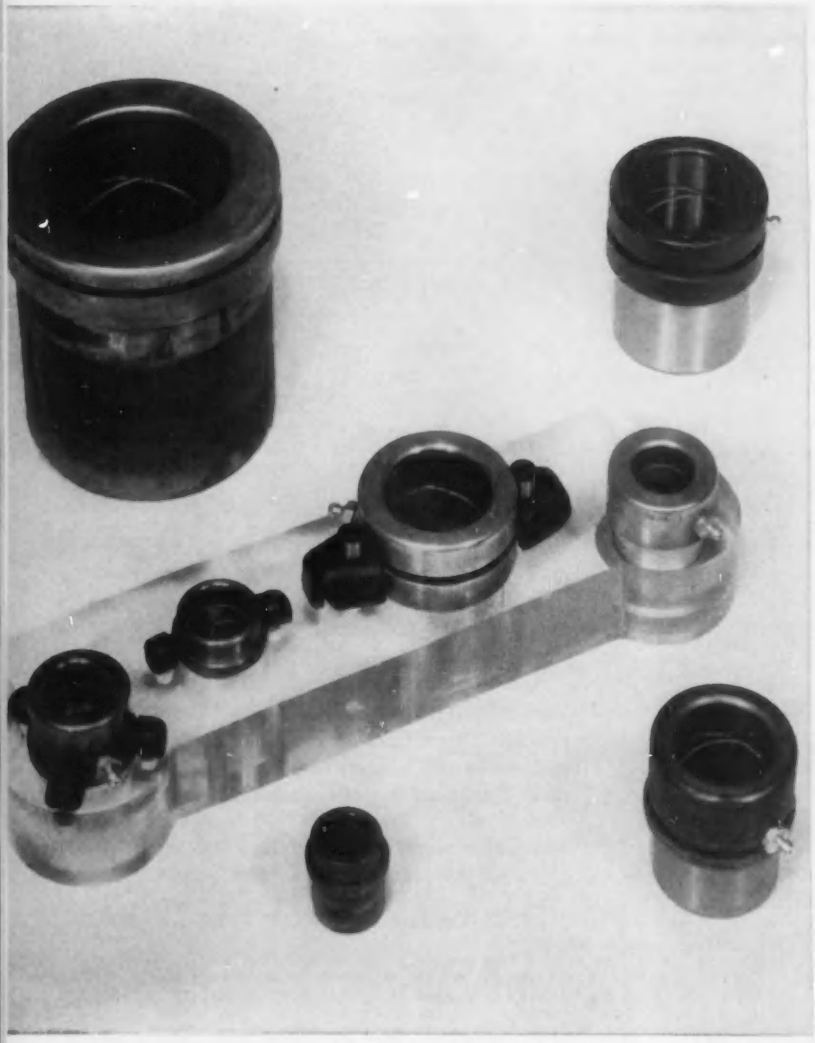
Armstrong

GASKET MATERIALS

. . . used wherever performance counts

How a better precision-fit Guide Pin Bushing* is made in less time with

SHELBY SEAMLESS MECHANICAL TUBING



Here is another manufacturer that is turning out a better product in less time by using Shelby Seamless Steel Tubing.

The product, a wring-fit bushing, makes possible a truly precision die set, which permits closer working tolerances and extends the life of the dies to a degree never before thought possible. The bushing itself is harder, stronger, more uniform, longer lasting and better fitting.

When Shelby Seamless Tubing is used, no boring is necessary—the hole is already there. It offers more, however, than just a pre-bored hole. It combines to an exceptional degree the qualities of strength, uniformity, and dimensional accuracy. These advantages, coupled with the workability and excellent machining properties of Shelby Seamless, make it the ideal material for critical mechanical applications like this.

Available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, Shelby Seamless Mechanical Tubing is produced to exacting standards by the world's largest manufacturer of tubular steel products. Get in touch with our engineers if you would like help in applying Shelby Seamless to your specifications.

*Manufacturer's name on request.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **SHELBY SEAMLESS MECHANICAL TUBING**

UNITED STATES STEEL

PRESENTING...

the NEW LINK-BELT MOTOGEAR

for bracket-mounting all foot-type NEMA motors—all makes and enclosures

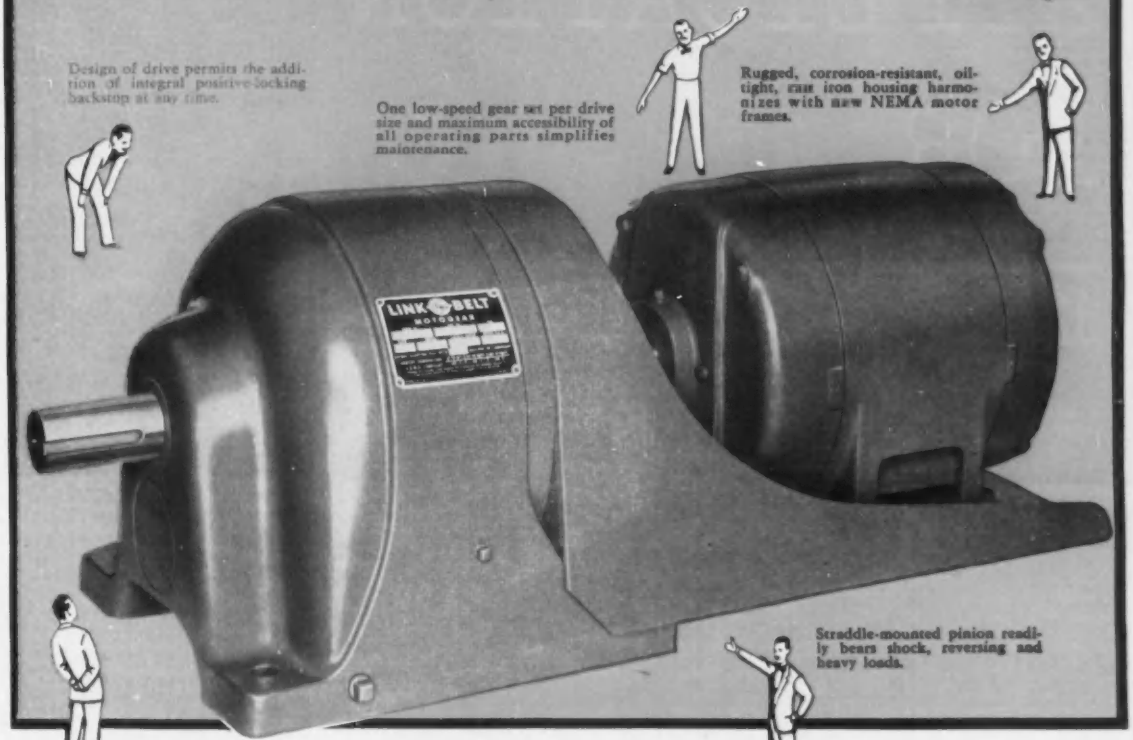
If drives in your plant operate continuously, the dependability of Link-Belt Motogears provides a sure means of minimizing costly, production-crippling downtime. Replacing a motor is simple and easy: just remove four bolts and separate the coupling—no need to drain oil. And design of the bracket assures rapid motor realignment. Sizes up to 60 hp; ratios from 6.2:1 to 292:1.

These are just a few of many advances in design you'll find detailed in 28-page Book 2447. Get a copy now from your nearest Link-Belt office or authorized distributor of Link-Belt products.

Design of drive permits the addition of integral positive-locking backstop at any time.

One low-speed gear set per drive size and maximum accessibility of all operating parts simplifies maintenance.

Rugged, corrosion-resistant, oil-tight, cast iron housing harmonizes with new NEMA motor frames.



Straddle-mounted pinion readily bears shock, reversing and heavy loads.

The new, improved Link-Belt line also includes compact Gearmotors with flange-mounted NEMA motors combining flexibility with outstanding design innovations.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,000

Qualifications	—Trained assembly engineer. Familiar with all present-day fastening techniques. In daily contact with engineering, production and purchasing departments.
Experience	—Can draw on the experience of more than a million applications. Successful record of pointing the way to assembly savings (often up to 50%) in 7 out of 10 cases.
Opportunity Wanted	—A chance to study your product (preferably in the design stage) and to make recommendations for speeding assembly, reducing spoilage, improving strength and reducing costs by means of the fast, effective P-K method.
"Tools"	—Parker-Kalon, the only complete line of Self-tapping Screws. The right "tool" fitted to every job.
Remarks	—No cost or obligation. For details, call your local Parker-Kalon distributor.

PARKER-KALON® *fasteners*

Parker-Kalon Division, General American Transportation Corporation—Clifton, New Jersey
Sold Everywhere Through Leading Industrial Distributors. Warehouse in Chicago, Illinois

over 8,000 Different Cylinder SELECTIONS—

Miller

AIR AND HYDRAULIC

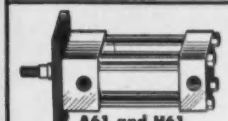
CYLINDERS AND BOOSTERS

"IN STOCK" for immediate delivery...

See Miller Bulletins A-105K(Air) and H-104K(Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

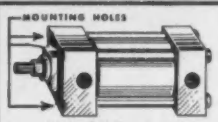
"IN-STOCK" MODELS

"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.

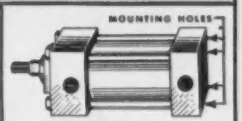


A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)

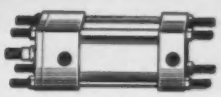
A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)



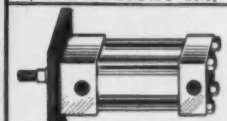
A63—8" Bore only
Flange Mounting on Rod End



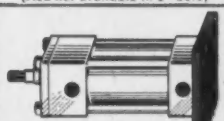
A64—8" Bore only
Flange Mounting on Cap End



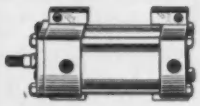
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



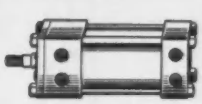
H65—Hydraulic Only
Flange Mounting on Rod End



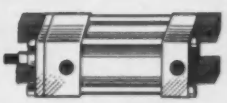
H66—Hydraulic Only
Flange Mounting on Cap End



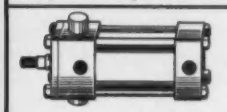
A72 and H72
Side Lug Mounting



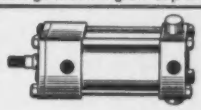
A74 and H74
Side Flush Mounting



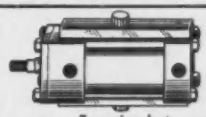
A77 and H77
Side or Foot Mounting



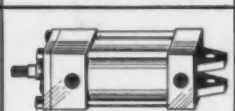
A81 and H81 Trunnion Mounting on Rod End



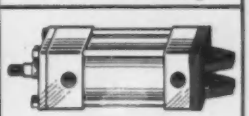
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap
(one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES in Inches

"IN-STOCK" STROKES (in inches)

	Bores	Rod Dia.	Rod Turn Down & Threads		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

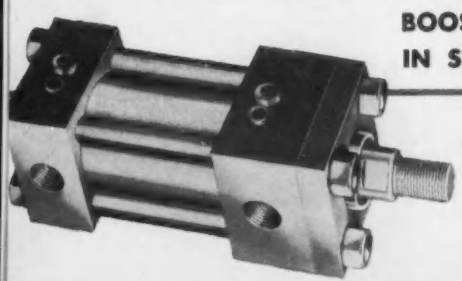
Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model 84, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-R8A8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.



Write For Catalog and Stock Price List

Miller

MILLER FLUID POWER DIVISION
FLICK-REEDY CORP.

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

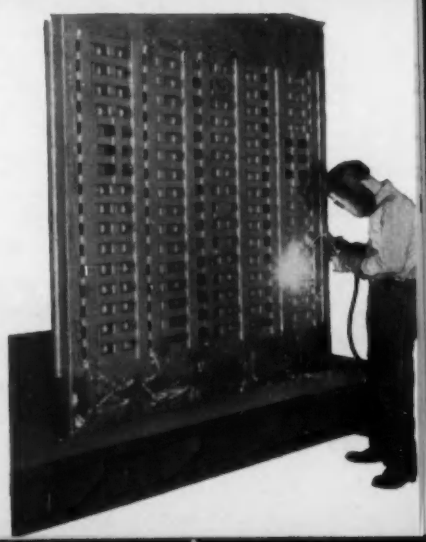
HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS...

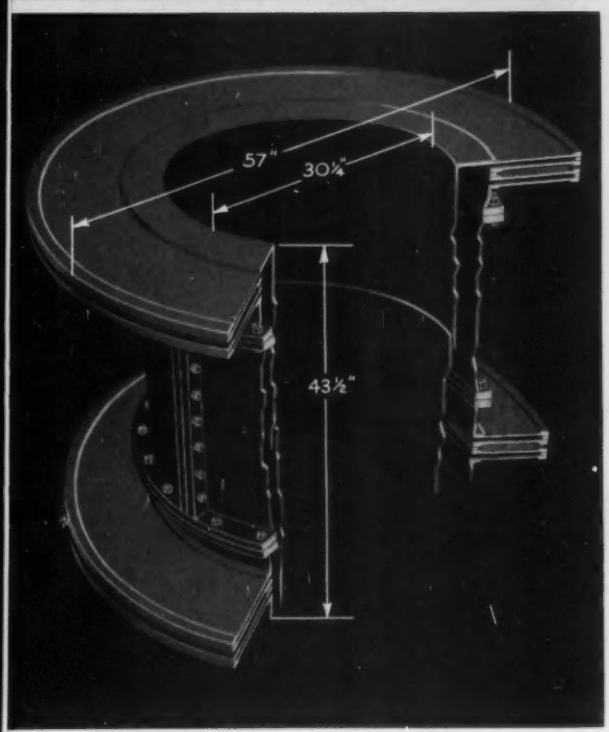
. . . Lops off 1,047 Pounds

Trays for ore clean-up buckets need tremendous resistance to impact, abuse and abrasion. Blaw-Knox Company, Pittsburgh, Pa., found that they weigh half a ton less, and cost less to fabricate when made from USS "T-1" Steel plate instead of heavy steel castings.

. . . 534 Easier Welds

This printing press bedplate, manufactured by Graver Tank & Manufacturing Co., Inc., must be welded in 534 places. High alloy steel with the needed strength was very difficult to weld. But USS "T-1" Steel is easy to weld . . . and has the needed strength to keep these bedplates, used on high-speed printing presses, as lightweight as possible.





. . . Saves $18,043

In structures like this, which are steel bellows that flex up-and-down and sideways, large thermal expansions can be accommodated. These expansion bellows surround struts which support a large axial flow compressor rotor. The bellows are connected from the compressor stator to the foundation. Westinghouse Electric Corporation switched to USS "T-1" Steel . . . promptly cut not only the cost of machining and welding, but also cost of the steel itself—saved $18,043.

. . . Three Ways Better

International Nickel Company of Canada expects USS "T-1" Steel to increase the service life, to reduce the maintenance, and lower the long-term cost of ore cars like this one; because "T-1" Steel has far greater strength, toughness, and resistance to abrasion than steel used previously. The car builder, Canadian Car and Foundry Co., Ltd., has had no difficulty fabricating this very strong alloy steel.

HOW USS "T-1" STEEL CAN HELP YOU

The great strength and toughness of USS "T-1" Steel (90,000 psi. minimum yield strength) helps you to increase the capacity and durability of power shovel buckets and storage tanks without increasing weight.

Its excellent weldability enables you to fabricate large equipment out in the field without heat treatment . . . thus, reduces fabricating and shipping costs and speeds up construction.

Its unusual toughness at sub-zero temperatures helps you to lengthen service life of equipment that must take impact, abrasion, and abuse in all weather.

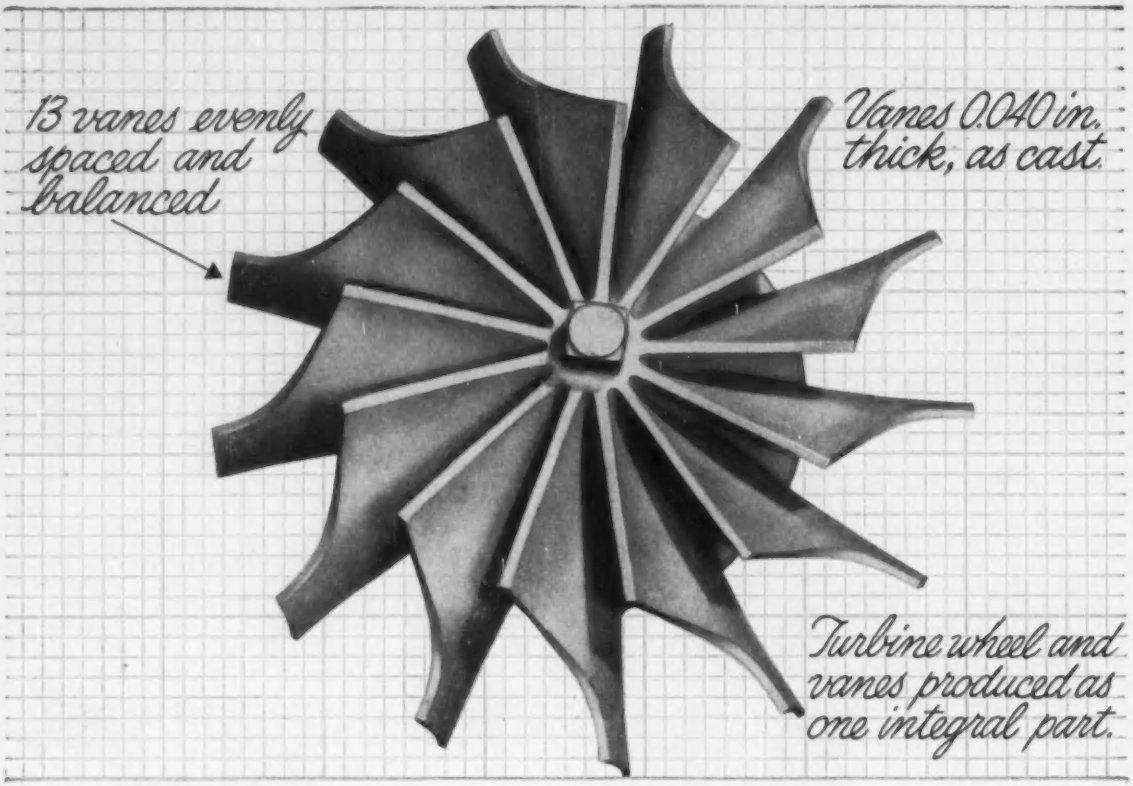
USS "T-1" Steel also gives you good creep rupture strength to 900° F. It often can be substituted for more expensive steels that are more difficult to fabricate. There is a place for "T-1" Steel somewhere in your designs. Write, wire, or phone for more information. United States Steel, Room 5288, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

UNITED STATES STEEL



Tough Design Problem Solved by Investment Casting . . . .

The precision-investment-casting process proved to be the most practical and economical way to produce an efficient turbine wheel for a diesel engine supercharger. The wheel rotates at 42,000 rev. per min. and is exposed to a 1450-deg. F. temperature. It had to be made of a hard-to-machine alloy capable of standing up under these severe service conditions. Yet, to operate efficiently, the vanes of the wheel had to be extremely thin and formed to an intricate shape.

The vanes and wheel were produced as one integral part by HAYNES' precision-investment casting process. Only two simple finishing operations were needed to put the wheel in service. The vanes are only 0.040 in. thick . . . too thin to produce by other methods without a prohibitive amount of machining on a hard, tough alloy.

The successful production of this turbine wheel points up one of the big advantages of HAYNES' precision-investment casting process . . . the planning freedom it offers to design engineers. For the full story on how this modern mass-production method can help you, contact one of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

Sales Offices

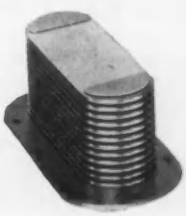
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

DIGS COOL!

AND HARRISON HEAT EXCHANGERS DO THE JOB!

Harrison helps move the earth . . . by making heat bite the dust! High-powered shovels—driven by Detroit Diesel 2-cycle engines—turn in dependable, low-cost performance when Harrison's on the job controlling the heat. You'll find Harrison heat control equipment on many of the nation's leading diesels and other power equipment. For manufacturers know they can depend on Harrison—with over 45 years' experience in manufacture, design and engineering research. If you have a cooling problem, look to Harrison for the answer.



GM GENERAL MOTORS

HARRISON

RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

TEMPERATURES MADE TO ORDER

Between motors and machines...

V-Belt Drives Run Your Plant

Texrope drive transmits power from Allis-Chalmers 300-hp motor to crusher used in copper ore processing.

V-BELT drives are the vital link connecting power and production line. As such, they must install easily, combine high efficiency with dependability, and require minimum maintenance.

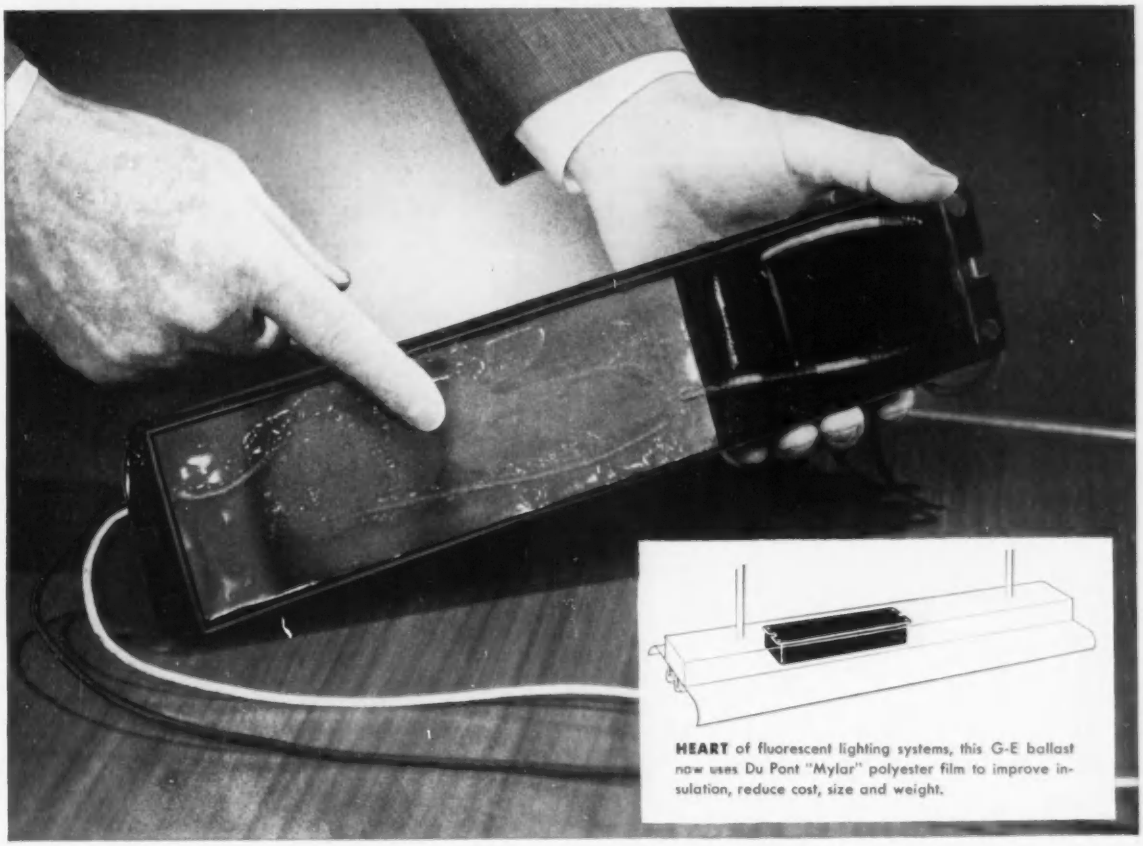
All these "vital link" characteristics are designed into *Texrope* V-belt drives by Allis-Chalmers, originator of multiple V-belt drives. *Texrope* drives feature specific advantages such as: *Magic-Grip* sheaves with "easy-on, easy-off" construction; the grommet belt which lasts 40% longer and costs no more than ordinary belts; and the *Vari-Pitch* sheave — the low-cost way to obtain variable speeds.

Whatever the application, there's one best *Texrope* drive to do the job most efficiently and economically. To find out more, contact your nearest Allis-Chalmers distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. A-4696

Texrope, Magic-Grip and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

MYLAR provides improved insulation...*



HEART of fluorescent lighting systems, this G-E ballast now uses Du Pont "Mylar" polyester film to improve insulation, reduce cost, size and weight.

G. E. reduces cost and weight by using Du Pont MYLAR® in ballast

General Electric selected "Mylar" as the insulating material for many of its fluorescent lamp ballasts.

Reasons? First, they needed a tough material with high dielectric strength. Next, it had to be easily applied and economically feasible.

Because of the hot potting compounds, the insulating material had to resist heat and chemicals. Lastly, it had to be thin and lightweight in order to provide compactness for reducing ballast space in fluorescent fixtures.

This successful application is only one of the many ways that versatile "Mylar", used alone or in combination with other materials, is making possible superior performance in capacitors, coils, motors and a host of other electrical products.

Perhaps "Mylar" can help *you* solve a knotty development problem or improve product performance. For more information on this unique polyester film and its applications in your field, send in the coupon for a fact-filled booklet. Be sure to indicate the type of application you have in mind.

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

DU PONT
MYLAR®
POLYESTER FILM

***MYLAR** *is Du Pont's registered trademark for its brand of polyester film*

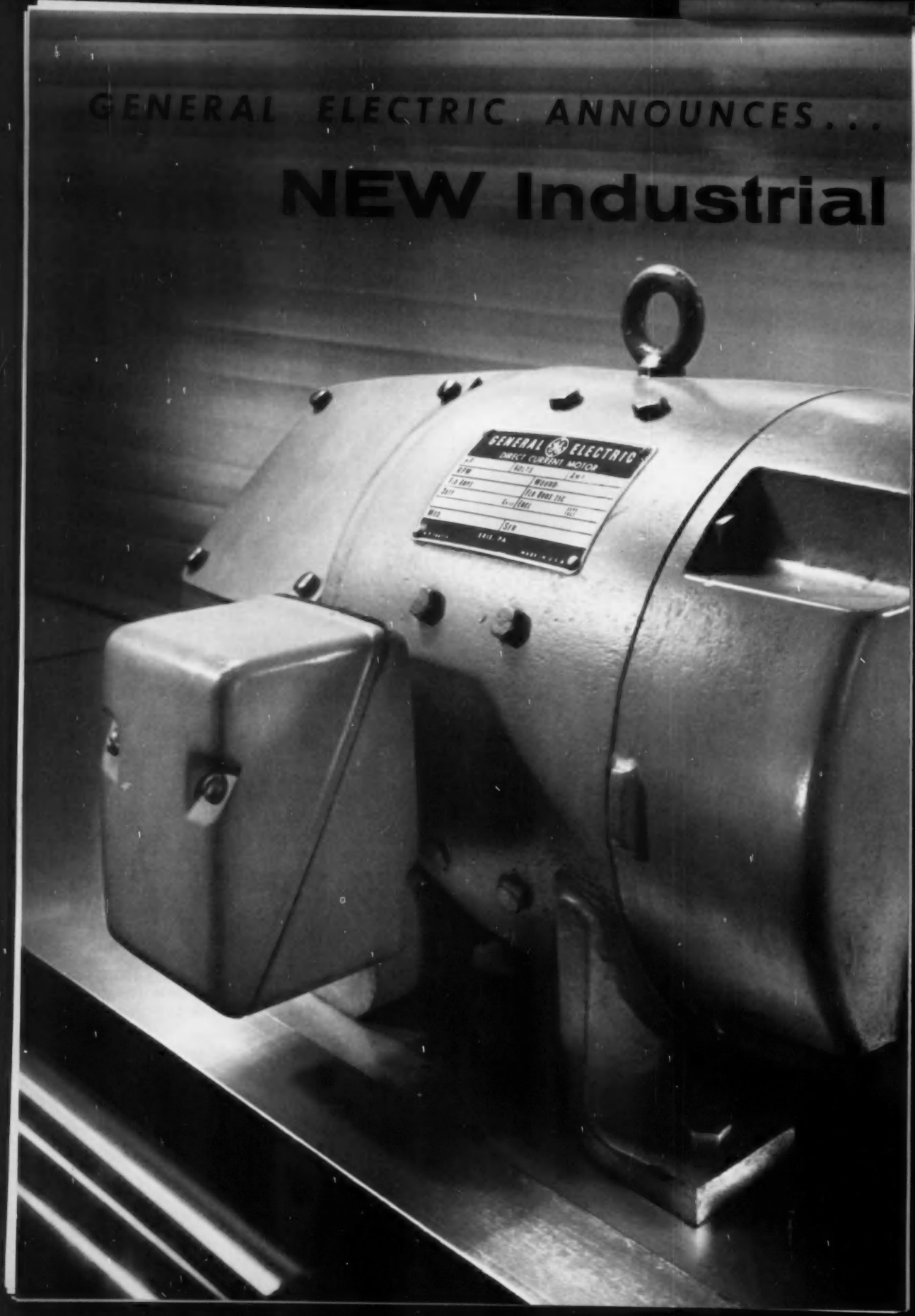
E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room P-6, Nemours Bldg., Wilmington 98, Del.

Please send the new booklet listing properties, applications, and types of "Mylar" polyester film available (MB-4).

Application_____
Name_____
Company_____
Address_____
City_____ State_____

GENERAL ELECTRIC ANNOUNCES...

NEW Industrial



Direct-current Motor

KINAMATIC* a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation—Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

Accelerated Production—The new d-c Kinamatic motor will modernize your equipment, give it increased power, higher speeds, greater output capacity. With the quick-acting G-E Kinamatic motor, your machines will process a greater variety of products . . . faster . . . easier . . . and with less maintenance and spoilage.

More Powerful—By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

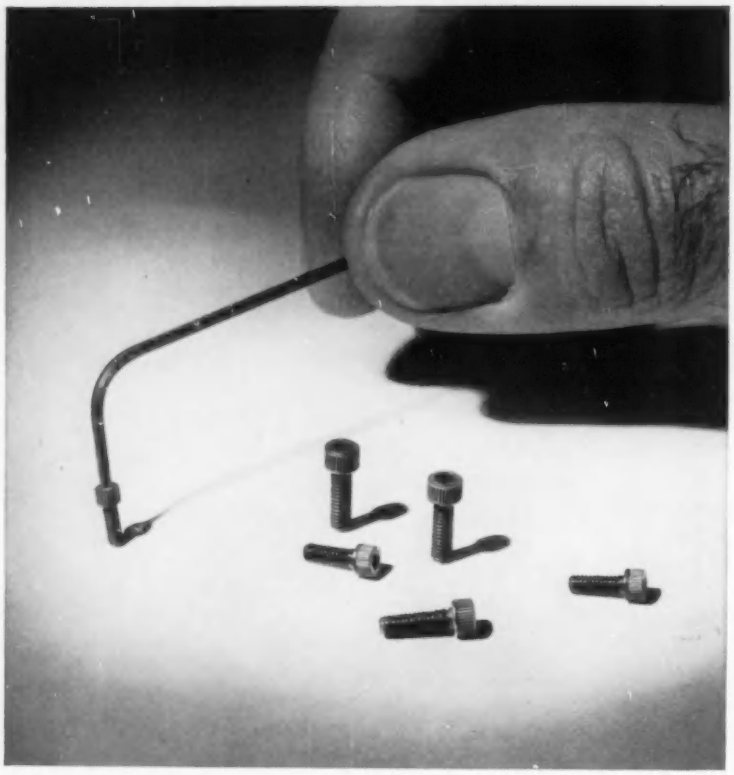
Engineering Help—Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 813-1

* Trade Mark of the General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC

Miniature screws aid standardization of small devices



Standard UNBRAKO miniature socket head cap screws are available in sizes # 0, # 1, # 2 and # 3, in heat-treated alloy steel or stainless steel, at your authorized industrial distributor's. Standard lengths range from ⅛ to ½ in.

Tiny close-tolerance Unbrako screws available in standard sizes

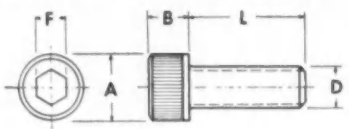
New economies in the design of space-saving miniature equipment are possible with these UNBRAKO miniature socket head cap screws. Manufactured to timepiece precision, available locally, they save the costly necessity of designing special screws to fasten tiny parts in compact units. They're ideal for use in typewriters, calculators and computers, servomechanisms, electric and electronic equipment—and in countless other small, intricate devices where maximum reduction in bulk and weight is required with no sacrifice in strength of individual components or assemblies.

Fingers grip the knurled heads on these tiny screws positively for easy handling and fast assembly. Uniform hex sockets assure maximum wrenching torque. Controlled fillets under the heads prevent shearing of the heads. Threads are fully formed for maximum strength and exact fit. Extremely accurate head diameters permit their use in countersunk holes, saving weight by reducing the length of the screw required and making flush designs possible.

These standard UNBRAKO miniature screws are available at your authorized industrial distributor's. See him today. Or write us for Bulletin 2055 and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

HEAT-TREATED ALLOY STEEL

Class 3 Fit Standard



	Diameter	Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0	A .104		80	⅛		2.0	.152
	B .060		80	3/16		2.0	.182
	D .060		80	¼		2.0	.210
	F .050		80	⅜		2.0	.265
#1	A .118		72	⅛		3.5	.27
	B .073		72	3/16		3.5	.32
	D .073		72	¼		3.5	.37
	F .050		72	⅜		3.5	.47
#2	A .140	56		3/16	6.0		.42
	B .086	56		¼	6.0		.50
	D .086	56		⅜	6.0		.58
	F 1/16	56		½	6.0		.70
#3	A .161	48		3/16	8.5		.59
	B .099	48		¼	8.5		.70
	D .099	48		⅜	8.5		.81
	F 5/64	48		½	8.5		1.03

Standard Screws are threaded to the head. Special materials, lengths, and threaded lengths are available. One "High-Titan" UNBRAKO hex key is included with each package of 100 screws.

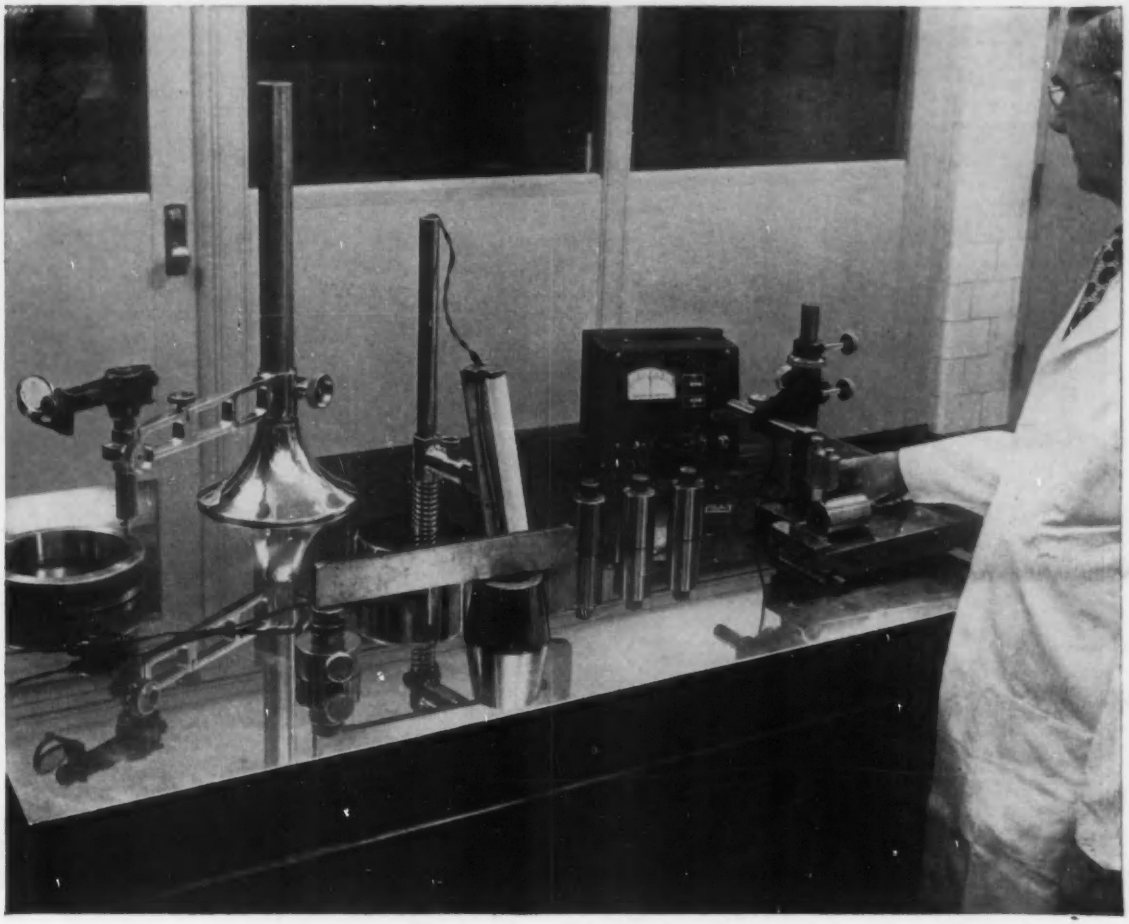
UNBRAKO®

SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA



How you can profit from a nation-wide search for accuracy

SCIENTISTS at the Massachusetts Institute of Technology were stymied on a top secret National Defense project. Some extremely accurate plug and ring gages were needed, but where to find a manufacturer capable of tackling an order calling for such extreme accuracy was the problem. The search eventually led to The Timken Roller Bearing Company. The M.I.T. engineers came to our Canton, Ohio, plant, were impressed with our gage facilities and our gage laboratory—acknowledged as one of the U. S. industry's finest—and asked if we would help them out.

Ordinarily we do not make gages for anyone's use other than our own, but because this was an important National Defense project, we agreed to make them. And we did.

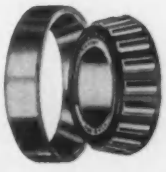
To make the finest roller bearings we need the most accurate gages. Our fine gage laboratory is one of the reasons that Timken® tapered roller bearings are considered to be the world's best.

So if you're looking for accuracy in the machines you build or buy, look to Timken tapered roller bearings. They practically eliminate friction, take any combination of radial and thrust loads, insure lasting precision. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭

BEARING TAKES RADIAL ▯ AND THRUST ▯— LOADS OR ANY COMBINATION ✳

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**

No Day is FRYDAY with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result — longer motor life assures you "repeat" business from your customers.

The engineered partner of A-C motors is Allis-Chalmers control.

Get Complete Information

To get the most from machinery you build, specify Allis-Chalmers components. Discuss your particular application with your nearby A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5052

THE BEARINGS WITH A MILLION OIL WELLS

Keystone Selflube BEARINGS

POROUS BRONZE and POROUS IRON

BETTER BEARINGS

because of

- UNIFORM POROSITY
- HIGHER OIL CONTENT
- COMPLETELY ALLOYED STRUCTURE
- GREATER MACHINABILITY
- TRUE CAPILLARY ACTION
- CLOSER TOLERANCES
- LONGER LIFE

Keystone controlled particle size and shape plus closely controlled sintering atmospheres provide a uniformly porous and completely alloyed bearing structure. Keystone's special vacuum impregnation technique achieves higher oil content per bearing, providing longer, quieter life. True capillary action through uniformly distributed voids meters oil evenly to bearing surface when shaft is in motion and retains oil when motion is stopped.

● *For better bearings, let Keystone quote on your needs!*

Write for your copy of our new "Standard Bearing Sizes" booklet, just off the press.

Keystone *Selflube* Bearing Material is also available in solid bar, cored bar, and plate stock.

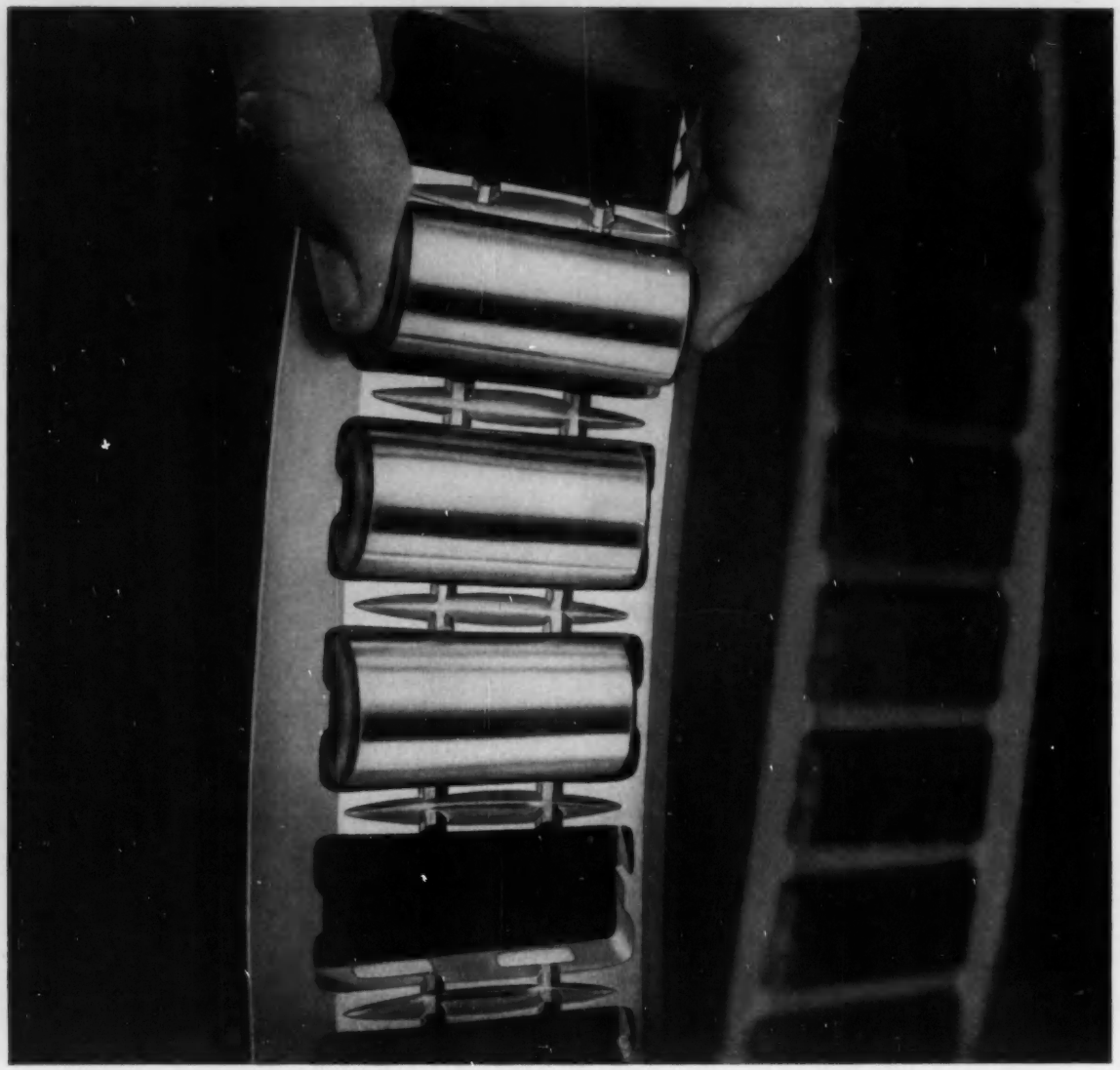
Keystone

CARBON COMPANY

POWDERED METAL DIVISION

ST. MARYS, PA.

TORRINGTON *TAPERED ROLLER* BEARINGS



Accurately caged... to cut your costs!

The one-piece, cast-bronze cage you see above is one of the reasons why TORRINGTON Roller Bearings give long, low-cost service. Note the individual roller retainment, for example. This helps keep the rollers thoroughly lubricated at all times. Race surface inspection is simplified. The machined pads in each roller pocket make sure the rollers are guided accurately at the pitch line. All this to minimize wear... lengthen bearing life.

Yes, TORRINGTON Roller Bearings cut your costs. They're made of the finest bearing quality steel available, heat treated by the most modern methods. No wonder they're so rugged... so dependable. Specify TORRINGTON *Tapered* or *Cylindrical* Roller Bearings for heavy loads and low maintenance.

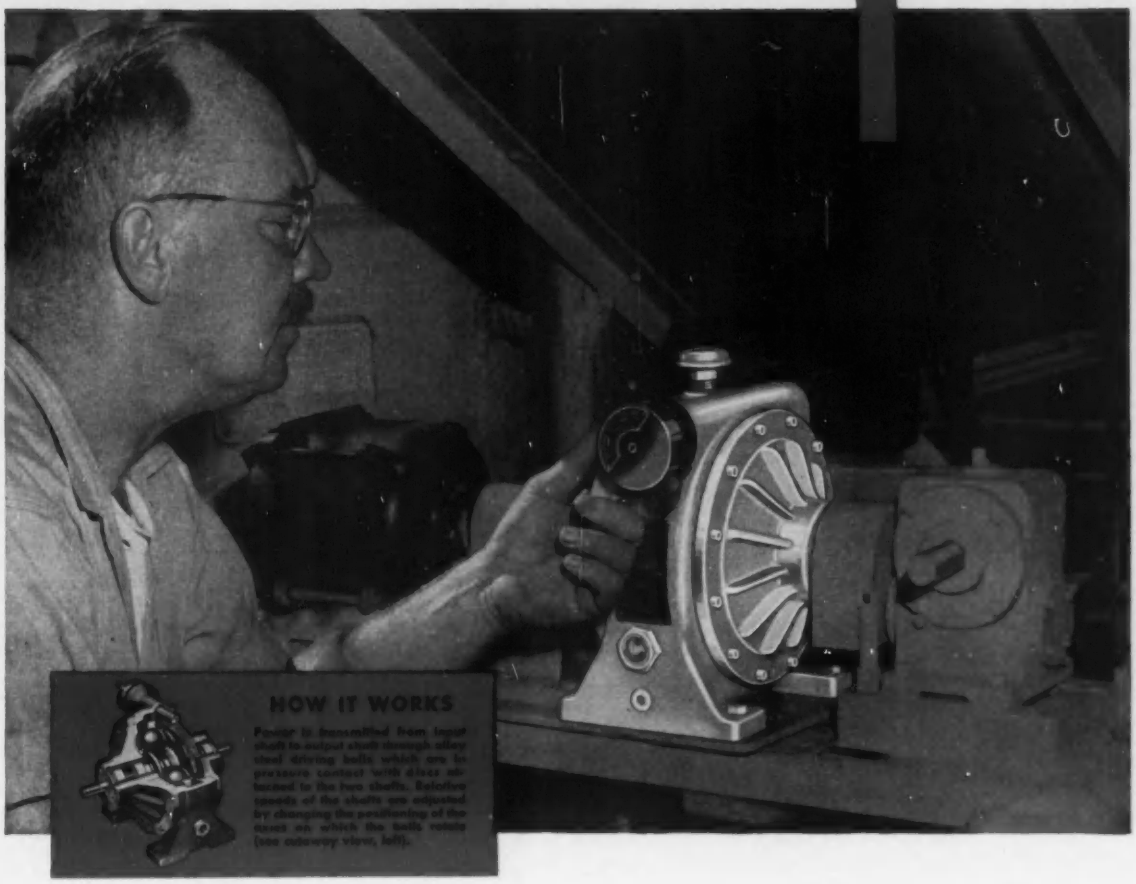
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller Needle • Ball • Needle Rollers

Major chemical producer meters flow of catalytic agents with Cleveland Speed Variator

A chemical research worker adjusts the manual control knob on the Cleveland Speed Variator to set the metering speed. Various types of regulating mechanisms can be mounted on the Variator to provide automatic adjustment by remote control.


HOW IT WORKS
Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the races on which the balls rotate (see cutaway view, left).

IN the research department of a major chemical plant, catalytic agents are metered and their flow varied with precision accuracy. This control is exercised with a Cleveland Speed Variator.

A ¼-horsepower electric motor is connected to the Cleveland Speed Variator driving a pump through a 25-1 speed reducer. Being infinitely variable, the Variator gives stepless speeds over its full 9:1 range—from ⅓ to 3 times input speed. Pumping speed can be varied from 207 to 23 rpm. This provides the necessary speed range for metering the various types of catalytic agents.

Available in eighteen standard types and sizes, the Cleveland Speed Variator offers these major advantages: 1. An extremely compact unit; 2. Almost any input speed up to 1800 rpm—clockwise or counterclockwise; 3. Constant horsepower output over a 9:1 range, or constant output torque with a 6:1 range; 4. Infinitely variable over entire speed range; 5. Rapid response to speed change, precise adjustment, accurate maintenance of settings; 6. Long life and minimum maintenance; 7. Ample bearing support for overhung pulleys on either input or output shafts.

Write for Bulletin K-200 for detailed description of the Cleveland Speed Variator, with photographs, sectional drawings, rating tables and specifications.

THE CLEVELAND WORM AND GEAR COMPANY

Speed Variator Division, 3279 East 80th St., Cleveland 4, Ohio

Sales representatives in all major industrial markets. In Canada—Peacock Brothers Limited.

See what adhesives are doing today!

A 3M ADHESIVE FASTENS DOWN THIS RUBBER MAT FOR KEEPS. IT'S CLEAN, QUICK AND EASY, MAKES NO MESS IN THE CAB INTERIOR.

Dressing up the "doghouse"

How would you fasten the trim on this truck engine cover? The fastener must fight heat, stress and vibration. And it has to be able to hold this rubber mat tight year after year, for hundreds of thousands of punishing miles.

Yet a 3M adhesive does the job. This worker quickly brushes EC-882 on the painted "doghouse", presses the rubber mat in place. High-strength, fast-drying EC-882 grips immediately and for keeps. In addition, EC-882 bonds rubber weather strip to the cab's enameled doors and door frames.

Another 3M adhesive, EC-871, fastens fibrous glass insulation to the cab roof and vinyl-coated jute to back and side panels. After 15 years of using 3M adhesives, this manufacturer can't recall one case of adhesive failure.

SEE WHAT ADHESIVES CAN DO FOR YOU! Hundreds of 3M adhesives serve many varied industries. Consult 3M research. Call your 3M Field Engineer. For a free booklet and information write: 3M, Dept. 46, 417 Piquette Ave., Detroit 2, Mich.

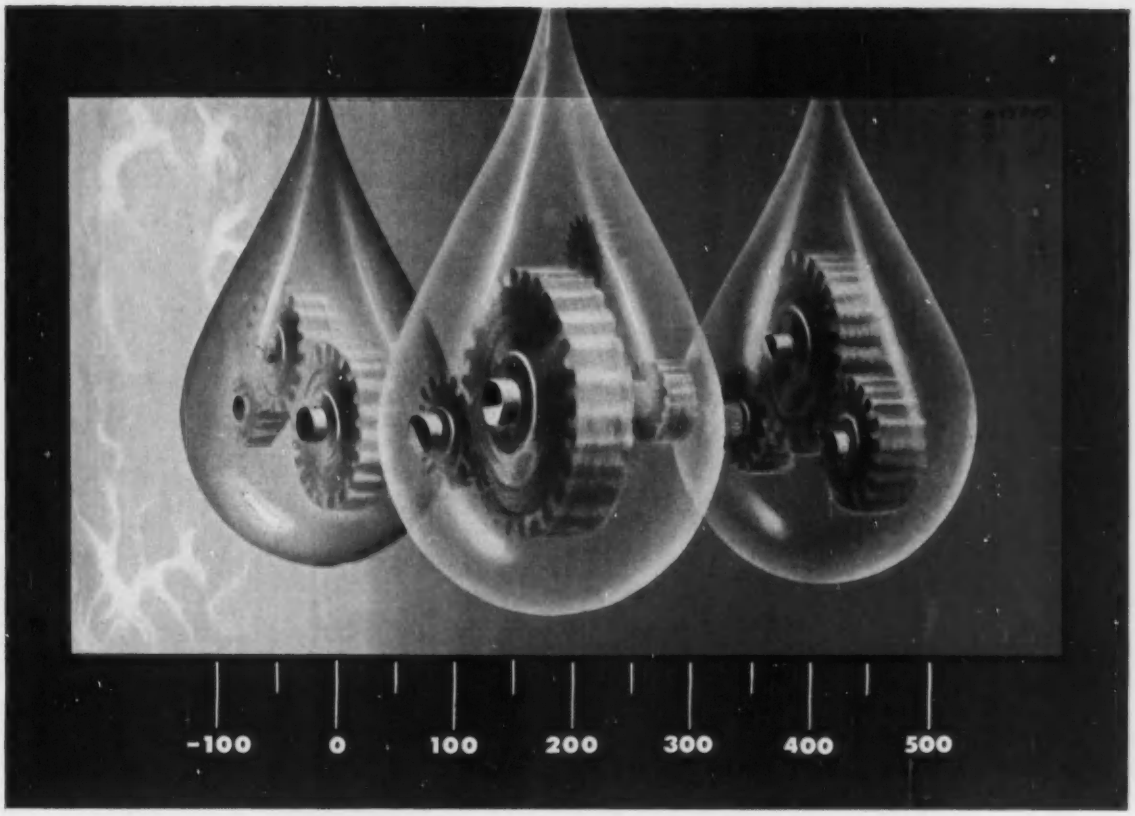
PRODUCT OF 3M RESEARCH

3M ADHESIVES

ADHESIVES AND COATINGS DIVISION, **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N. Y. 16, N. Y. • CANADA: P. O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



Are you bothered by "hot lubrication" problems?

If your oil or grease won't stand up under extreme heat (or cold) you'll want to know more about silicone lubricants that withstand 500 above—or 100 below! Five years of General Electric research have resulted in *silicone lubricants*. Called Versilube® fluid and grease, these new lubricants withstand temperatures *up* to 500 above, *down* to 100 below zero F.

Yes, *silicones that lubricate*. Proof? General Electric gave its new silicone lubricants this rigorous test: *lubricating heavy-duty jet-engine gears*. In these tests, Versilube F-50 fluid prevented scoring as well as petroleum or synthetic diester oils, while providing many times the thermal stability and life afforded by the conventional lubricants.

Versilube fluid and grease offer all the amazing characteristics of silicones in general: Long life at high temperatures; slight change of viscosity with change in temperature; ready flowability at low temperatures.

Where can silicone lubrication help YOU? Especially if you are in one of the "hot" industries—steel, glass or ceramics—you'll want to find out how General Electric Versilube fluid and grease can increase the reliability and performance of lubricating systems . . . or provide the key to lubrication savings.

Start *now* to realize the benefits of Versilube lubricants! For data sheets and free experimental sample, just fill in and mail the coupon.

Progress Is Our Most Important Product

GENERAL ELECTRIC

SILICONE PRODUCTS DEPARTMENT **Section 65-1C**
GENERAL ELECTRIC COMPANY **WATERFORD, NEW YORK**

Please send me product and application data on:

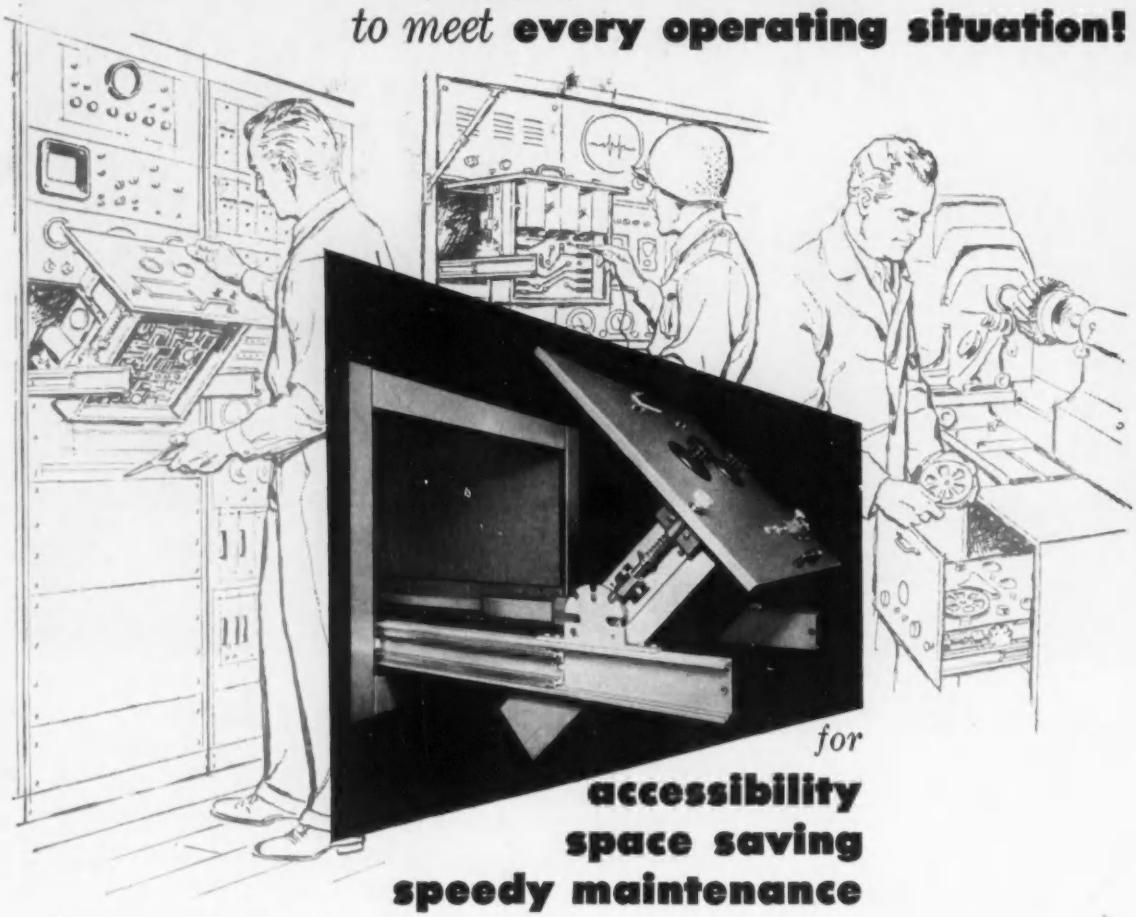
( ) G-E Versilube F-50 (fluid) ( ) Include sample
( ) G-E Versilube G-300 (grease) ( ) Include sample

Name_____
Position_____
Firm_____
Street_____
City_____ Zone____ State_____

IN CANADA: MAIL TO CANADIAN GENERAL ELECTRIC CO., LTD., TORONTO

over **100** *designs of* **Grant INDUSTRIAL SLIDES**

to meet **every operating situation!**



for

accessibility
space saving
speedy maintenance

Grant Industrial Slides afford substantial, practical mountings for nearly all types of assemblies—electronic, hydraulic, pneumatic, mechanical. They allow quick access... the pivoting types permit testing or work on underside as well as top of chassis... also provide for quick release of chassis for bench servicing. Slide mounting usually eliminates need for rear access doors and rear aisles—a very important saving of space. Grant slides are soundly engineered, durable and dependable. Load capacities range up to 500 lbs. and more.

Grant engineers and representatives in all important industrial areas offer specialized experience—will aid in working out custom variations to adapt standard slides to especially exacting requirements.

Ask For This Important Working Data

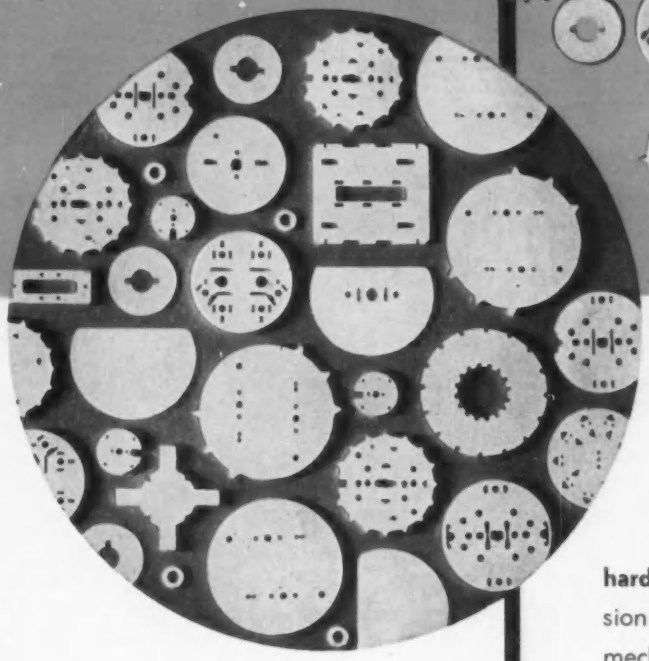
The Grant Industrial Slide Catalogue is a working manual on built-in accessibility. Ask us to mail your free copy.

Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation
31-77 Whitestone Parkway, Flushing 54, N.Y.
944 Long Beach Avenue, Los Angeles 21, Calif.

"A proven success!"

Thin, Accurate AlSiMag® ALUMINA CERAMICS for Electron Tubes



AlSiMag Alumina ceramics as thin as .009" have demonstrated outstanding advantages as electron tube components. Their success in this demanding application opens up new fields of design opportunity for these versatile materials.

Why not investigate the possibilities of AlSiMag Alumina ceramics for your applications? Send blueprint or sketch with details of operation for complete information. Special Alumina Bulletin No. 562 will be sent on request.

Do you need a material with **superior electrical characteristics at high temperatures and frequencies . . . strong,** high compressive, flexural and tensile strengths . . . **hard,** 9 on Mohs' scale, resists wear and abrasion of most known materials . . . **rugged,** resists mechanical shock, vibration, high operating temperatures . . . **chemically inert . . . resists repeated hot-cold shock . . . thermally conductive,** dissipates heat by rapid thermal conduction? All are possible in the many AlSiMag Aluminas.

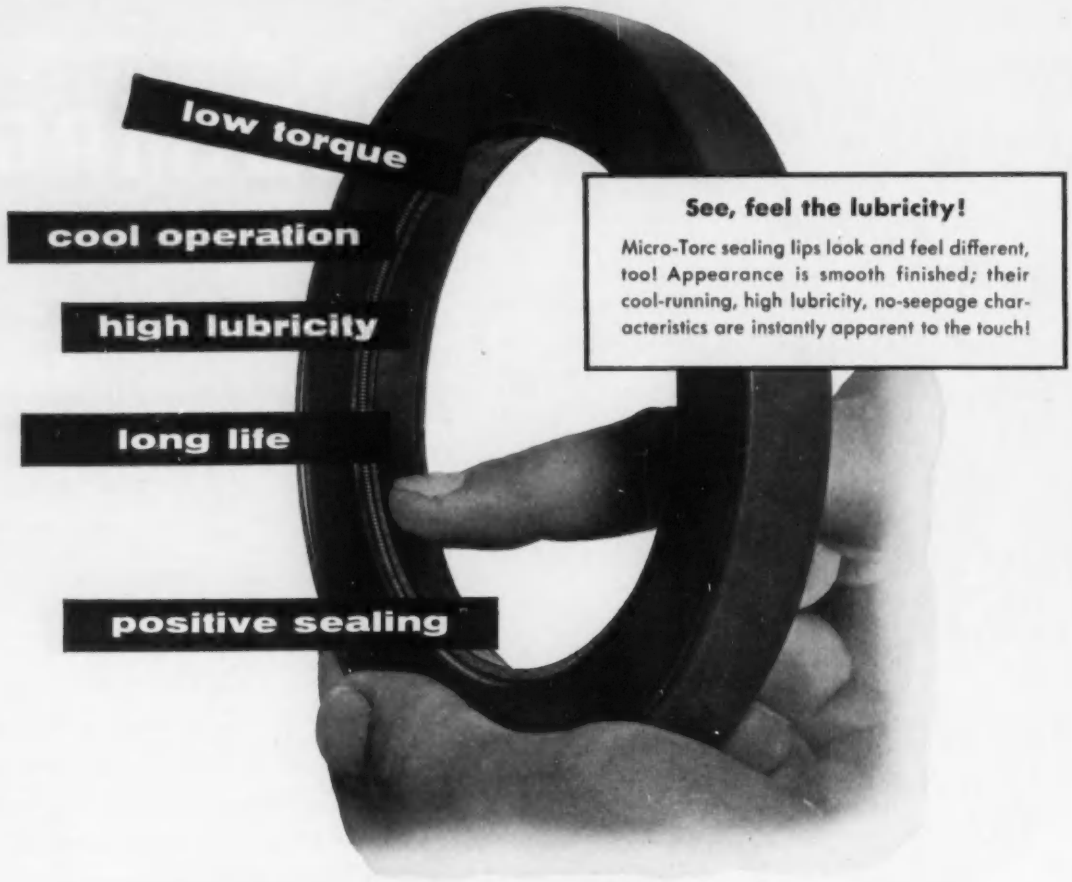
Precision tolerances can be maintained. Surfaces may be ground or polished to 10 micro inches. Shipped in any desired quantity—within your tolerance spread and promised delivery cycle.

A Subsidiary of Minnesota Mining and Manufacturing Company

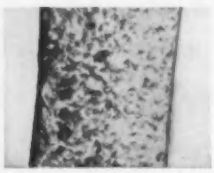
AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
55TH YEAR OF CERAMIC LEADERSHIP

Branch offices in these cities (see your local telephone directory): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas • Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia, Pa. • St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla. **Canada:** Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Mfg. Co., International Division, 99 Park Ave., New York, N. Y.


low torque
cool operation
high lubricity
long life
positive sealing
See, feel the lubricity!
Micro-Torc sealing lips look and feel different, too! Appearance is smooth finished; their cool-running, high lubricity, no-seepage characteristics are instantly apparent to the touch!

NATIONAL MICRO-TORC* LEATHER OIL SEALS



How Micro-Torc works—Side of chrome retanned leather lip is coated with dry lubricant and elastomer. Elastomer binds lubricant to leather, prevents seepage through leather, enhances mechanical stability—yet permits leather's natural porosity to remain in body of sealing lip. Lip actually stores oil for dry or emergency running!

For applications where temperatures are within —50° to 200° F, and shaft speeds are not over 2000 rpm with runout .015 or better, new National Micro-Torc oil seals should definitely be investigated.

The Micro-Torc sealing member is perhaps the most interesting advance in leather oil seals in 15 years. In hundreds of thousands of hours of actual application, Micro-Torc seals have consistently shown up to 80% less torque and 10 times the life of other leather seals. Breakaway torque is normally only 20% of conventional leather seals, and Micro-Torc seals have operated up to 100 hours dry at 1,350 rpm without sloughing or squealing. Properly used, Micro-Torc seals provide positive sealing throughout service life.

Get complete details. Call nearest NMB Engineer, or write for Bulletin.
Engineering help in your plant and ours. NMB'S Application Engineering Service is fast, expert, convenient. Yours for the asking:

CHICAGO, ILL.	*Room 462 McCormick Building, HArrison 7-5163*
CLEVELAND, OHIO	*210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS	*2520 West Mockingbird Lane, DIxon 7541*
DETROIT, MICH.	*13836 Puritan Avenue, VErmont 6-1909*
DOWNEY (Los Angeles Co.), CALIF.	*11634 Patton Rd., TOpaz 2-8163*
INDIANAPOLIS, INDIANA	*2802 North Delaware Street, WAlnut 3-1535*
KANSAS CITY, MO.	*4445 Terrace, LOgan 6622*
MILWAUKEE, WIS.	*647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J.	*1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF.	*Broadway and National, EMerson 6-3861*
WICHITA, KANSAS	*519 South Broadway, AMherst 2-6971*

*T. M. REG.

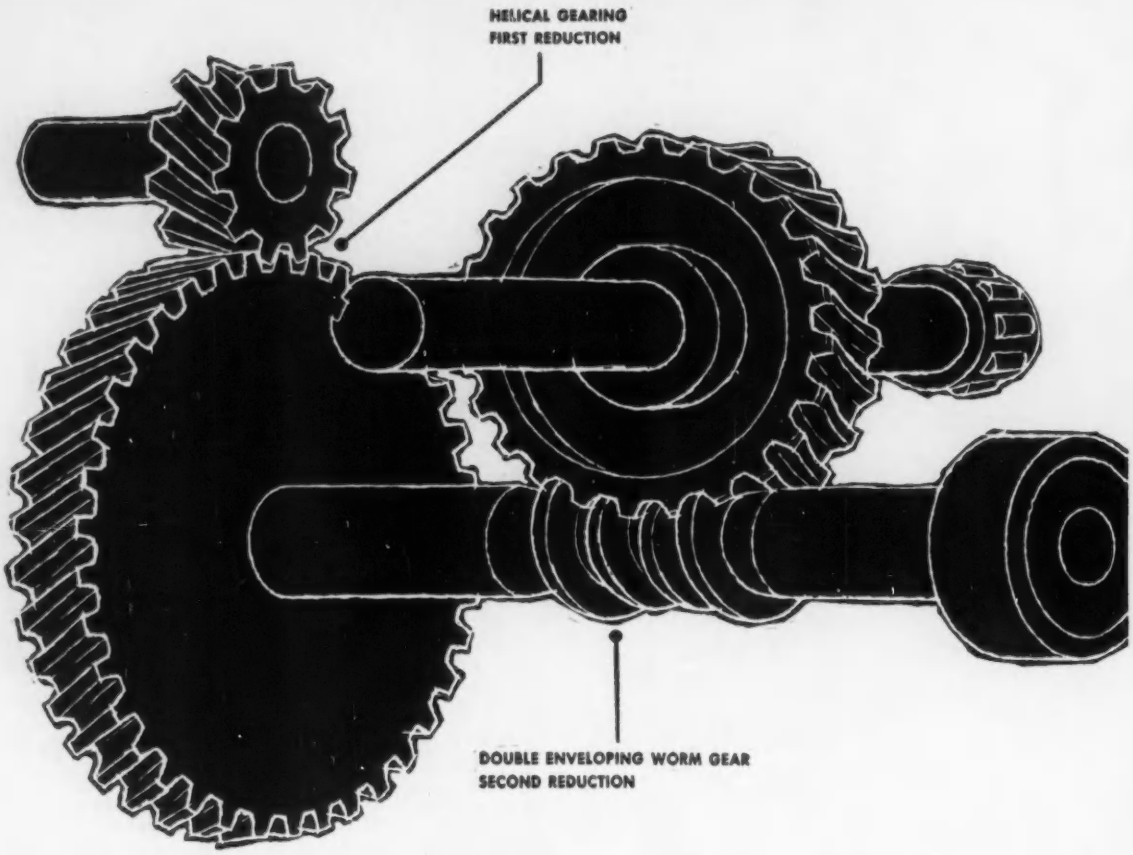
NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS
Product of the world's largest exclusive manufacturer of oil seals

3675

NATIONAL MOTOR BEARING CO., INC.
Plants at Van Wert, Ohio, Redwood City, Downey and Long Beach, Calif.
General Offices: Redwood City

THE shape of things to come is often seen in the aluminum extrusions being made by Revere for the country's manufacturing leaders. These are the companies that know how great a difference may exist between the design of a new shape on paper and the delivery of a fine extrusion in aluminum. They come to Revere for the experience and service needed to bridge this gap. It will pay you, likewise, to gear the progress of your business to the most dependable sources of supply.

Revere Aluminum Mill Products include extruded shapes, tube, rod and bar; coiled and flat sheet, embossed sheet, circles and blanks; seamless drawn and welded tube; rolled shapes; electrical conductors; forgings; and foil. Call the nearest Revere Sales Office now. In all principal cities. Revere Copper and Brass Incorporated. Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.



How Westinghouse new right-angle gearmotor delivers 32% more power

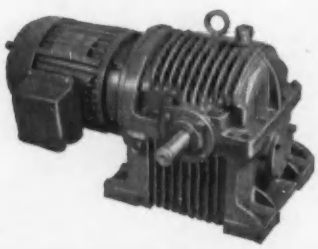
With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-07349-A



WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

What shape is a quality fastener?

Here is a handful of ELASTIC STOP® nuts. Each has ESNA's familiar red locking collar . . . is self-locking and vibration-proof. Each is a readily assembled, one-piece unit. Each provides positive protection against thread corrosion . . . prevents liquid seepage along bolts. Each is made from the finest of raw materials. Each is exactly controlled as to finished dimensions, class of thread fit and finish. Each is now in use on critical applications, with a record for uniform high quality that is unmatched.

Most of them are standard parts. Some originated as the result of a specific request for ESNA's help with an important fastening problem.

Isn't it logical to call on us with your next fastening problem?

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA TRADE MARK

ROLLPIN TRADEMARK

Elastic Stop Nut Corporation of America
Dept. N62-62, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ **ELASTIC STOP nut bulletin**

☐ **Here is a drawing of our product. What self-locking fastener would you suggest?**

Name_____ **Title**_____

Firm_____

Street_____

City_____ **Zone**_____ **State**_____

tough, versatile

U.S. Royalite the sheet fabricating material that turns designers' dreams into practical realities

Is the case, cabinet, cover or other part of your product now made of a material which leaves something to be desired in . . .

Economy? Royalite® assures exact, inexpensive prototypes . . . lower tooling, finishing and assembly cost . . . fewer operations.

Beauty? Royalite molds readily to shape, detail and contour . . . retaining its eye-catching, sales-appealing color and texture.

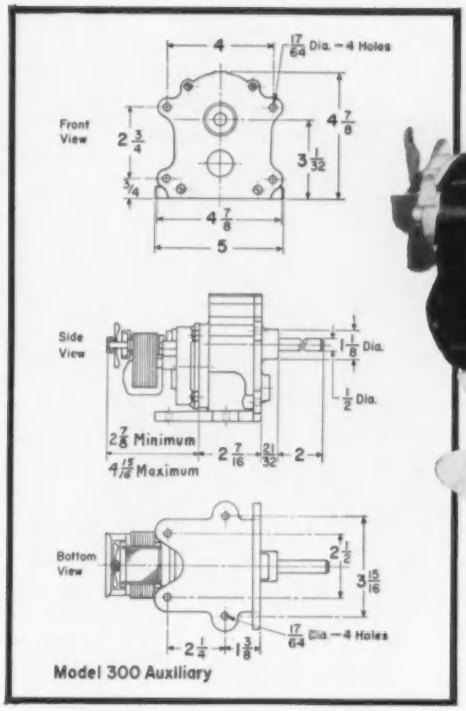
Durability? Patented compounding of thermoplastic fortified with rubber gives never-before wearability. It's super-tough to resist impact . . . yet weighs less than any metal. Custom formulized to meet specific needs such as oil and chemical resistance, moisture-resistance, and performance at extremes in temperature.

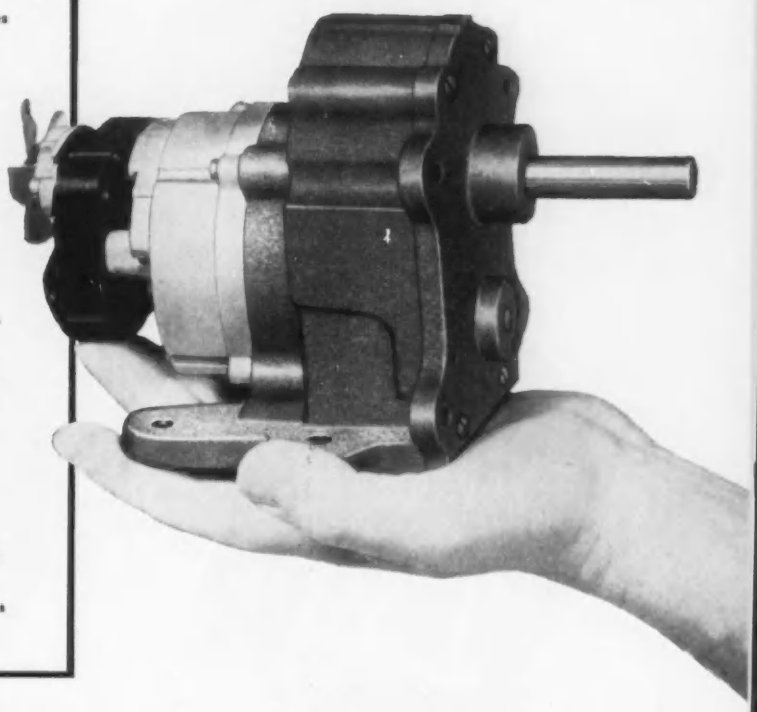
See these designers' dreams come true at the Royalite Display, National Plastics Show, Coliseum in New York . . . June 11 to 15—Booth No. 1212

United States Rubber

2638 N. Pulaski Road, Chicago 39, Illinois

POWER UNDER CONTROL





Here's a Motor Looking for Work

The newest in the line of Merkle-Korff fhp geared motors is the model #300 shown above. This unit, in continuous duty service, will deliver up to 300 lb. in. torque, yet it fits in the palm of your hand. The motor is ideally suited for applications requiring the operation of heavy cams, cranks or gears mounted directly on the motor shaft.

A typical torque table is shown below. This table shows no-load speeds for uni-directional shaded pole induction motors. The loads are the maximum under which the motor will start and operate continuously without over-load. The range of speeds shown are representative of those most commonly used. If the maximum rated torque is required at speeds greater than shown, modifications can usually be made, or the unit can be furnished at speeds as low as 1 RPH or slower.

This model #300 is only one of a long and varied line of Merkle-Korff fhp geared motors. They range in speed from 800 RPM down to any fractional RPM required. Merkle-Korff motors can be furnished either with induction shaded pole motors, or with synchronous, reversing, series, or shunt wound motors. These motors are furnished in a wide range of horse power ratings depending upon the output shaft torque requirements.

Merkle-Korff engineers will assist your design staff in specifying the unit best suited to your requirements.

TORQUE TABLE
MODEL 300

rpm	stator thickness 9/16"	13/16"	1 1/2"
10	25 lb. in.	33 lb. in.	60 lb. in.
8	30	40	75
6	42	54	100
5	50	65	120
4	62	80	150
3 1/2	70	92	170
3	80	108	200
2 1/2	100	130	240
2	125	162	300
1 1/2	166	216	300
1	250	300	"
1/2	300	"	"

MERKLE-KORFF GEAR CO.

219 NORTH MORGAN STREET • CHICAGO 7 • ILLINOIS

EDWIN M. BOND
Box 333, Rumson, N. J.

RALPH D. EARNEST ASSOCIATES
12818 Puritan Ave., Detroit 27, Mich.

HENRY F. KAELIN
1412 S. Los Angeles St., Los Angeles 14, Calif.

HOW Formica IMPROVED FABRICATED PART PERFORMANCE AND SAVED 23%!

Formica studied performance requirements, developed a special grade, produced a better part, and saved the customer 52c a pound.

Are you buying laminated plastic properties you don't need? Or are you paying the penalty of poor product performance because you've been short-changed on essential properties?

You can never be sure until you have a Formica fabricating engineer check your performance requirements. Tell him what you need, where and how you'll be using your fabricated part. Then he'll select the *one grade* that's best and most economical for you.

With 52 standard grades, and a competent research staff to develop special new ones, there's never any compromise with grade selection at Formica. And design modifications recommended by Formica fabricating engineers will further help to produce a better part, frequently at big savings.

This fabricating service is part of Formica-4, designed to give you the best grade at lowest cost for your application. Call your Formica district office or send us your blueprints and your performance requirements. Formica Corporation, subsidiary of American Cyanamid, 4676 Spring Grove Ave., Cincinnati 32, Ohio.

Your *blueprint* tells only *half* the story...

... tell us your performance requirements and we'll save you money

FORMICA 4

Getting more service hours per dollar

HOW TO SPECIFY FLEXIBLE METAL HOSE

3 simple steps can help you select metal hose for best results and longer service life

The important job of selecting the *most economical*, the *one right* flexible metal hose for your product or transfer problem can be greatly simplified by following these 3 steps:

1 Send exact specifications

Complete and exact statement of operating conditions will go far in saving you money on flexible metal hose.

First, it assures you that the connector you get will live up to your expectations. And, second, that manufacturers won't bid on hose that's "over-engineered." You'll save in the long run because you'll get the right assembly for every job.

Here is the information we need before we can give you our best suggestions:

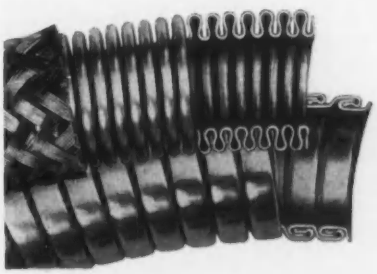
A PHYSICAL REQUIREMENTS:

1) *Over-all length (including fittings)*
2) *Diameter (I.D. and O.D.)*
3) *Fittings—size, type, style of thread*
4) *Tolerances permitted*
5) *Quantity required*

B OPERATING REQUIREMENTS:

1) *Material to be conveyed*
2) *Operating pressures—is there shock?*
3) *Operating temperatures*
4) *Movement—lateral and longitudinal*
5) *Vibration conditions?*
6) *Expansion and contraction requirements?*
7) *Corrosive atmosphere?*

Send sketch of proposed installation if available.



BASIC TYPES

CORRUGATED and STRIP-WOUND. In a wide range of sizes and styles in any workable metal. Various fittings.

2 Use standard metal hose where possible

Many standard connectors have been developed to meet problems common to many finished products—i.e., vibration. Often a standard metal hose will answer your needs as well as a special item could. We can often save you money if we know operating requirements.

3 Call the Man from Anaconda to help you select, specify, test

When selecting or specifying flexible metal hose, you'll find American's staff of trained engineers of invaluable assistance. Their advice and suggestions may help you solve or avoid many costly problems.

NEW INFORMATION

American Flexible Metal Hose and Tubing Catalog puts all the information you are looking for—both technical and general at your fingertips. Get your copy today, free of charge. Mail coupon below. 56177

WHEREVER CONNECTORS MUST MOVE

AMERICAN

FLEXIBLE METAL HOSE AND TUBING

an **ANACONDA®** product

THE AMERICAN BRASS COMPANY
American Metal Hose Division, Waterbury 20, Conn.

Please send me your free Quick Reference Catalog CC-400 containing basic information on all types of metal hose and tubing, fittings, etc.

NAME & TITLE.....

ADDRESS.....

COMPANY.....

CITY, ZONE, STATE.....

Aluminum SHAPES

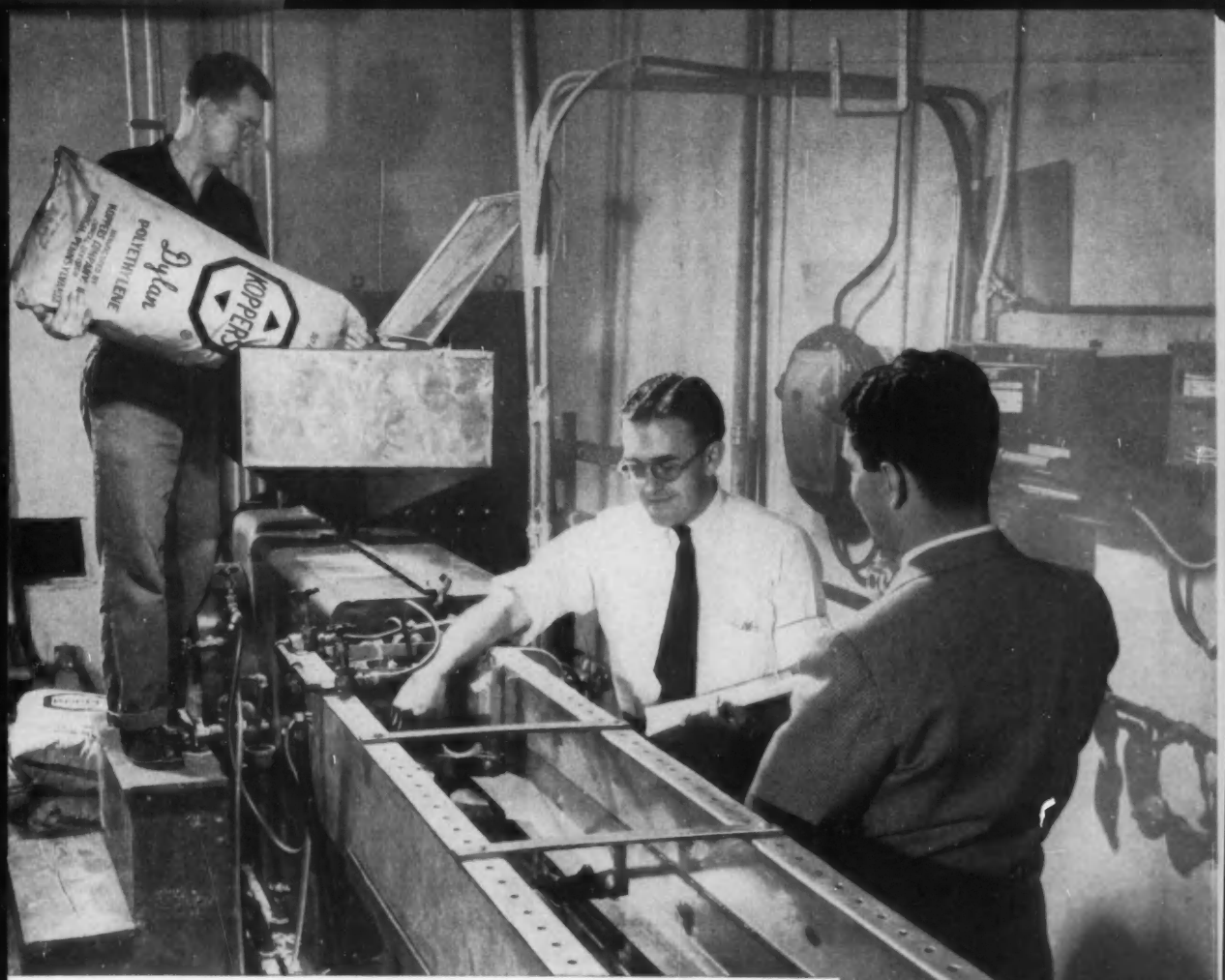
by ROLL FORMED

Aluminum shapes reduce production costs and eliminate waste. Let **ROLL FORMED** deliver your aluminum shapes notched and cut to length. **ROLL FORMED** shapes are uniform and accurate—made to your most rigid specifications. **ROLL FORMED** shapes are controlled through all phases of tool design, roll making and final production. Send us your blueprints for shapes in carbon, galvanized and stainless steel, copper, zinc, clad metals, as well as aluminum. Let us show you how our modern plant facilities can produce your sections at lower costs to you.

Write for Catalog No. 1053

ROLL FORMED PRODUCTS
COMPANY

MAIN OFFICE AND PLANT 3756 OAKWOOD AVE. • YOUNGSTOWN, OHIO



TEAMWORK ON THE JOB
helps solve pipe extrusion problems

Teamwork is certainly an essential part of any business, and Koppers engineers welcome the opportunity to be on your production team.

These specialists are ready and willing to offer service and technical advice, both on the production line or in the planning stage. They will help you unsnarl production problems, and help improve your product quality. Moreover, they will arrange to supply you with DYLAN* polyethylene for pipe extrusion and many other uses.

For technical service or further information on DYLAN polyethylene contact Koppers Company, Inc., Chemical Division, Dept. PE-66, Pittsburgh 19, Pennsylvania.

*Koppers Trademark

KOPPERS

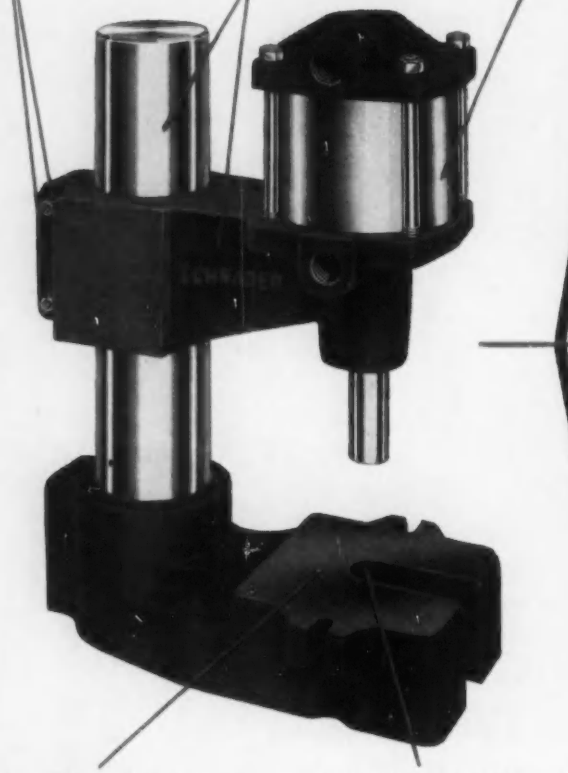
KOPPERS PLASTICS

Sales Offices: NEW YORK • BOSTON • PHILADELPHIA • ATLANTA • CHICAGO
DETROIT • HOUSTON • LOS ANGELES
In Canada: Dominion Anilines and Chemicals, Ltd., Toronto, Ontario

TWO-BOLT CLAMPING adjusts easily, positively from 0" to 7" in height, and swing arc 2" each side of center.

HEAVY-DUTY CYLINDER with extra heavy wall, tie rods and piston construction for longer life.

RIGID STEEL COLUMN and rugged cylinder bracket are accurately machined for precision work.



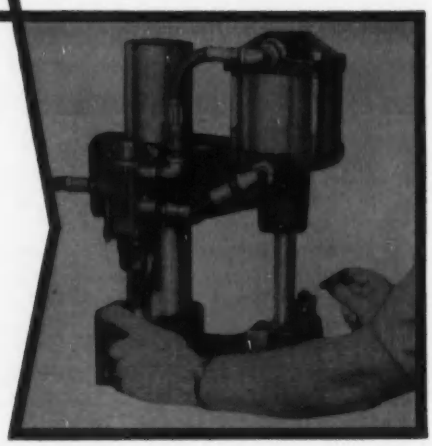
HEAVY, RUGGED BASE forms sturdy foundation for large machined-surface table area.

SPECIAL RECESS IN TABLE provides for punch-through operations.

NEW SCHRADER AIR PRESS

It's compact and power packed!

It stamps, coins, broaches, rivets, stakes, presses, shapes, bends, assembles—*many other uses!*



Modern "muscles" of compressed air never tire . . . get more work done at less cost!

This modern Air Press has unlimited possibilities for speed, power, positive performance. Available as single acting for impact jobs; double acting for squeeze and power withdrawals. It requires minimum space, next to no maintenance, is extremely versatile in adapting to operating controls. Can't be beat for low cost practicality.

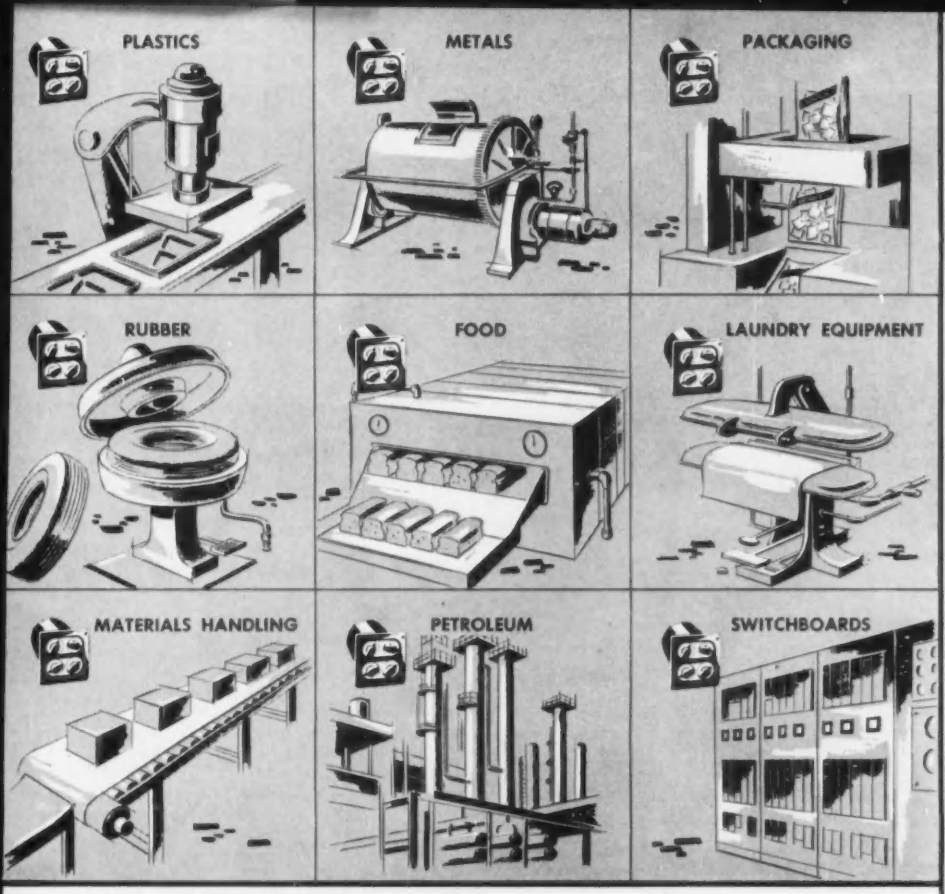
Important feature: Control and speed of the extra heavy cylinder and ram can be varied as necessary, by using standard Schrader Air Control Accessories that adjust in seconds.

Write for Catalog data describing Air Press fully—including variety of controls, accessories and prices. You'll be surprised at the low prices!

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
470 Vanderbilt Avenue, Brooklyn 38, N. Y.

Schrader®
ESTABLISHED IN 1844

LEADERS IN AIR CONTROL SINCE 1844



In All These Applications . . .

3 NEW FEATURES OF G-E INTERVAL TIMER IMPROVE CONTROL AND CUT TIMING COSTS

To give you even greater versatility in time control, the General Electric TSA-18 interval timer may now be equipped with these optional features: new reset contacts, elapsed time indication and a program retaining mechanism.

NEW RESET CONTACTS make possible *either* automatic resetting or automatic recycling in the same timer. A simple change in external wiring is all that is necessary to change from one to the other. With *automatic resetting* you can eliminate manual resetting or mortgaging another circuit to achieve the reset action. With *automatic recycling*, the timer will reset at the end of a time cycle and immediately start the next cycle. This gives you a continuous repeating time-cycle program.

ELAPSED-TIME INDICATION, shown by a small dial on the timer face, gives you a continuous, accurate reading of time elapsed from the start of your time-cycle program—especially useful on long programs.

PROGRAM RETAINING: In case of power failure the program-retaining mechanism will hold the timer at the point of interruption and restart it at this point when power is restored. (Cannot be used in the same timer with reset contacts.)

MANY STANDARD "EXTRAS" are included in the TSA-18 timer: delayed on-and-off timing in intervals from 1 second to 30 hours; knob-locking device to prevent missetting; high setting accuracy of 1%; high repeat accuracy of ¼%; dust-proof case—*all standard at no extra cost.*

YOUR COSTS ARE REDUCED because the TSA-18 interval timer will increase the equipment operators can handle and free them for more productive activity. Waste or spoilage of materials can also be reduced, with the higher degree of uniformity that G-E timed control gives you.

For further information, contact your nearest General Electric Apparatus Sales Office, or write for bulletin GEC-1223 to Section 584-3, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

G-E TSA-18 TIMER WILL REDUCE COSTS IN ALL THESE OPERATIONS

IN PLASTICS
Automatic molding
Scheduled mixing of materials
Batch weighing

IN METALS
Heat treating
Flame hardening
Induction heater annealing
Quenching cycles
Firing of regenerative furnaces
Plating
Bath and soak cycles
Motor reversing cycles—tumbling
Batch weighing
Sequencial adding of materials

IN FOOD PROCESSING
Sugar centrifuge control
Dough mixing
Dehydration equipment
Automatic chicken pickers
Roasting processes
Motor reversing cycles—agitators
Adding ingredients in sequence
Infra-red oven control
Molding and pressing
Batch weighing
Bag folders
Heat sealers—plastic bags
Bag and box fillers

IN MACHINE TOOLS
Flame hardening
Heat treating
Resurfacing of grinding wheels
Final polishing intervals
Periodic lubrication

IN RUBBER
Tire and tube curing cycles
Injection period control

IN CHEMICALS
Motor reversing cycles—agitators
Atomic radiation control—setting exposure reading interval
Batch weighing
Sequencial adding of materials
Testing photographic emulsions
Infra-red oven control
Purging of filtration tanks
Dehydration equipment

IN CONTROL PANELS
Single time-interval operation
Multiple time-interval operation
Recycling of timed operations
Sequencial cycling of automatic machines
Motor-reversing cycles
Reclosing of circuit breakers
Unattended substation starting

AND MANY OTHERS
Transit-system scheduling
Glass polishing cycles
Spin and surge protection of deep well pumps
Automatic paint spraying devices
Photo copying equipment
Automatic door closing
Dry cleaning and laundry machines
Alarm initiation
Dust collectors and shakers
Quality control
Materials handling
Periodic test sampling

A HANDFUL OF CHIPS...

tells the COST-CUTTING story of Chase® FREE-CUTTING Brass Rod!

Take a close look at the typical chips machined from Chase Free-Cutting Brass Rod. See how short, brittle and tightly curled they are. They could only have come from rod that permits really high cutting speeds and heavier feeds *without gumming or jamming!*

Such remarkable chips also indicate the *quality at low-cost* of *finished pieces* machined from Chase Free-Cutting Brass Rod. Smoother, cleaner pieces that take precision threads and sharp knurls—require less polishing—and simplify lacquering, enameling or plating.

The Chase warehouse near you stocks standard mill lengths in many different cross-sections. Special shapes that *save even more* machining time can be made to order.

Write, wire or phone today!

Chase

BRASS & COPPER CO.

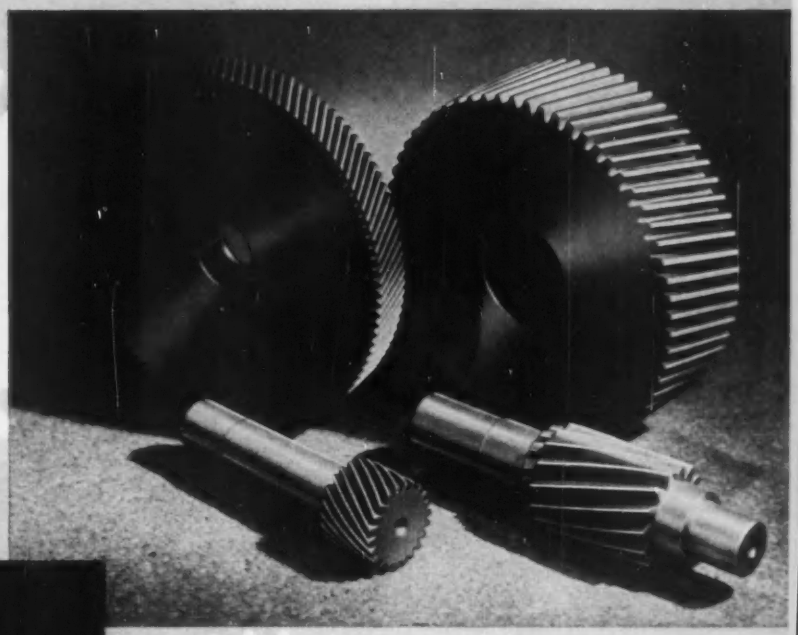
WATERBURY 20, CONNECTICUT
SUBSIDIARY OF KENNECOTT COPPER CORPORATION

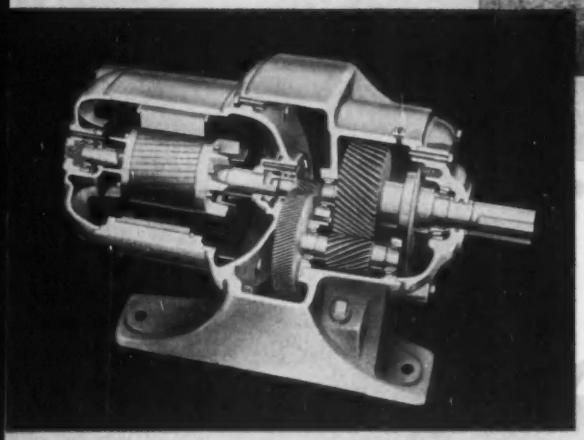
The Nation's Headquarters for Brass & Copper

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury

GEARS *match Motor Reliability*

Both Gearing and Motor of the **SYNCROGEAR** are "Custom-built" by **U. S.** to the same high quality



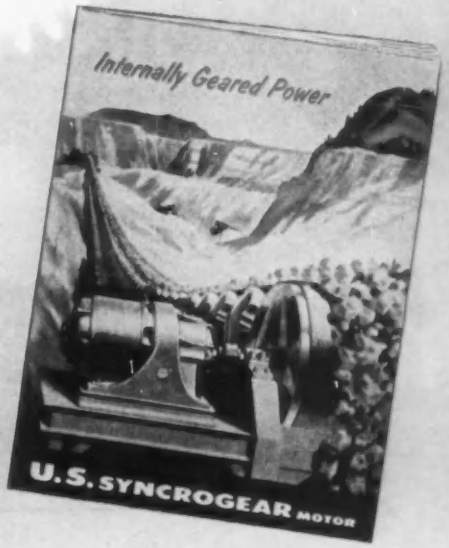


U. S. SYNCROGEARS have a proven record of dependable service with longest life under rugged conditions...

The Mighty

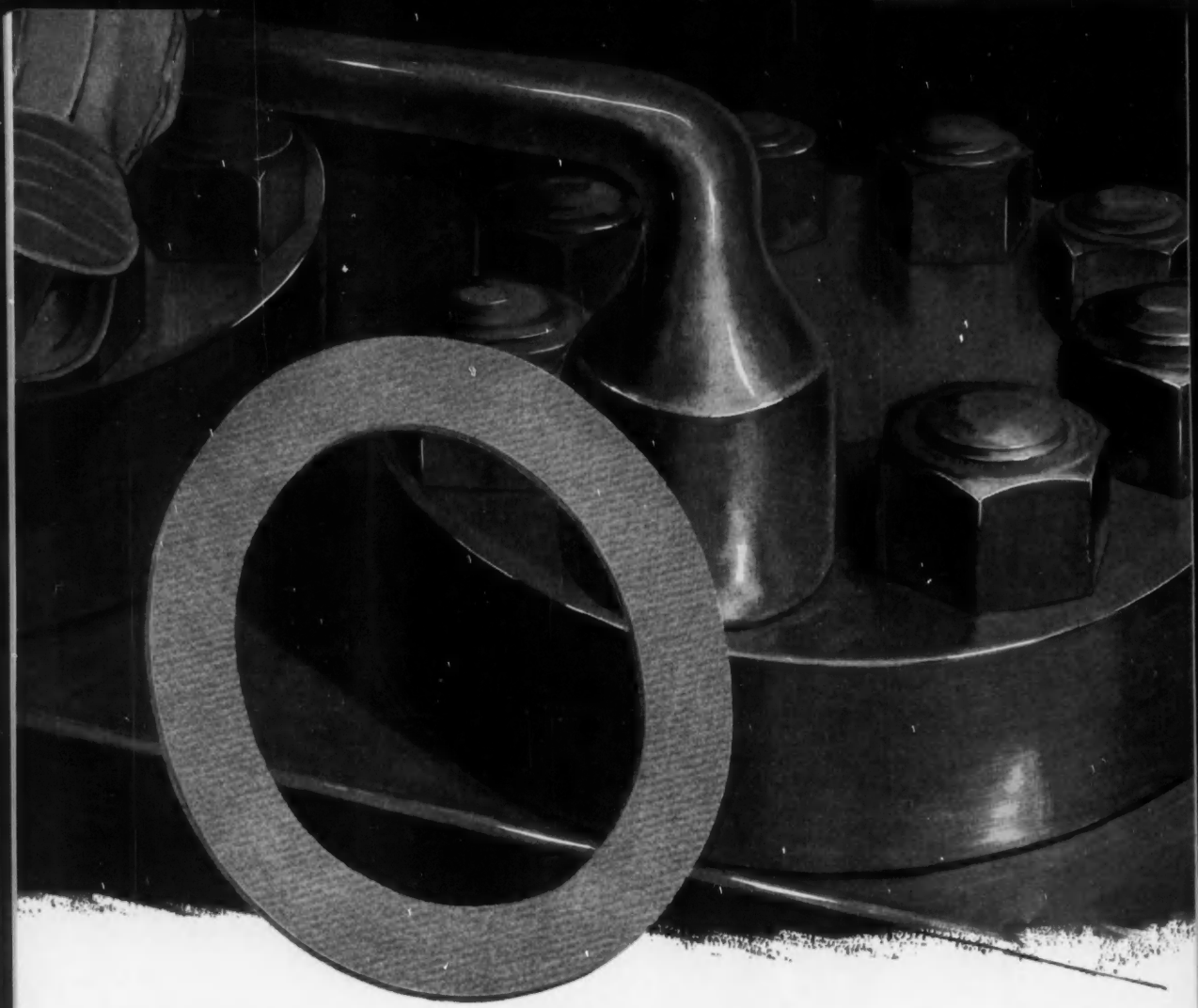
U. S. SYNCROGEAR MOTOR

Completely described and illustrated in our new 16-page full-color brochure. Learn about new techniques in gear making for gear motors. In addition to custom-engineered gears, U.S. Syncrogear motors incorporate many other advanced life-lengthening features, including: genuine pyramidal design; completely enclosed case; solid shank ever-tight pinion; friction-free oil seal; asbestos-protected windings; normalized castings and Lubriflush transverse lubrication.



U.S. *Electrical* MOTORS

P.O. Box 2058, Los Angeles 54, Calif., or Milford, Conn.

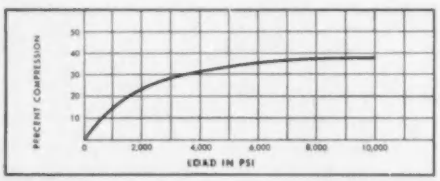


New heavy-duty fiber gasket seals at up to 250° F.

Combinations of heat and pressure that cause ordinary plant fiber gaskets to fail are handled successfully by Armstrong Accopac® N-820—a dense new material made by a patented Armstrong process. It requires a minimum flange load of 2,000 psi and seals at temperatures up to 250° F.

The special latex binder in N-820 will not leach out in alternately wet-and-dry applications. Shrinkage due to binder loss is eliminated because N-820's binder is non-volatile and non-extractable. It stays in.

N-820 conforms well to flange surfaces, yet permits minimum torque loss. It is already being used successfully on a wide range of heavy-duty applications, often as an economical replacement for asbestos sheet packing where temperatures do not exceed 250° F. For data sheet and samples, write to Armstrong Cork Co., 7006 Irvin St., Lancaster, Penna.



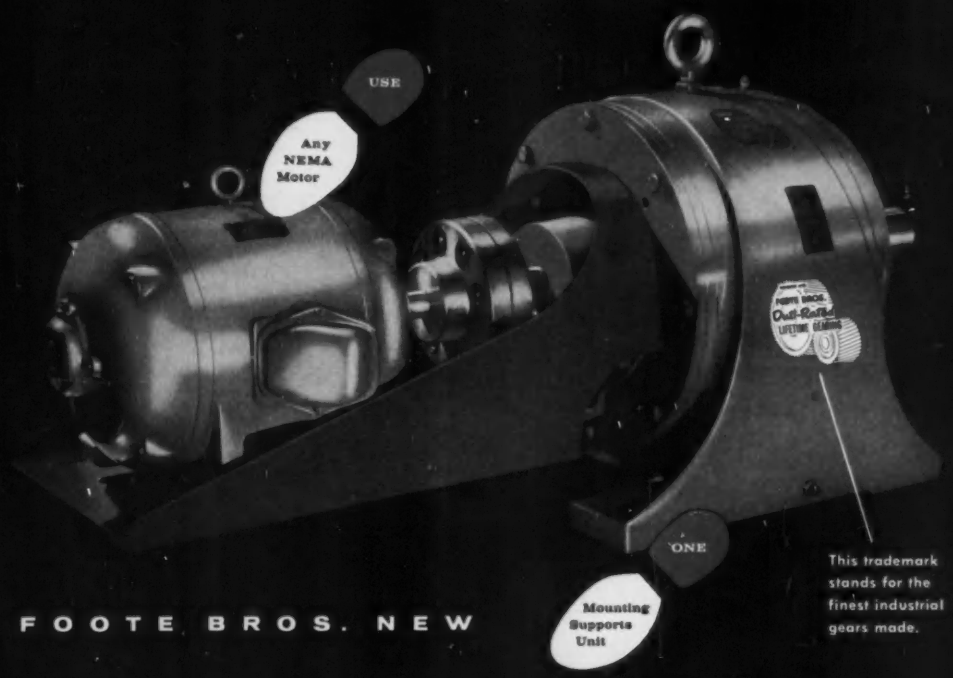
COMPRESSIBILITY. N-820, less compressible than other Accopac materials, is recommended for heavy-duty applications where minimum flange pressures will be 2,000 psi and where temperatures will not exceed 250° F.

Armstrong ACCOPAC

. . . used wherever performance counts

Basic Idea

SOLVES MANY REDUCER MOUNTING PROBLEMS



FOOTE BROS. NEW

Line-O-Motor Drive

One base supports both speed reducer and motor in this simple, practical and foolproof mounting system . . . Now you can use standard N.E.M.A. motors and make change-overs in minutes—reducing both costly down-time and motor inventory.

Line-O-Power motorized drive solves many old problems . . . and opens new fields of advanced design for new applications. Available 1-75 H. P. for all Service Classes—Horizontal, Vertical, and Vertical Extended with Foot or Flange mounting—Double or Triple Reduction units available in Ratios from 5.06:1 to 238:1.

FOOTE BROS.

Better Power Transmission Through Better Gears

4545 S. WESTERN BLVD., CHICAGO 9, ILLINOIS

Write for your Line-O-Motor Catalog today

ANOTHER NEW DEVELOPMENT IN PACKING DESIGN

PRE-FORMED SHOULDER AND FLARE MAKE CUP PACKINGS FIT BETTER

Houghton's newly designed leather cup packings are pre-formed. They *fit* the square corner normally found between the end of the piston and the cylinder wall.

As a result, there is no distortion of the packings under operating pressure. They are not forced into a *new* shape which would cause premature wear, fracture or breakdown at the heel. In addition, the side walls are molded with a slight flare which provides sufficient pre-loading for perfect sealing at minimum pressures.

This leadership in hydraulic know-how is typical of Houghton, who makes all types of hydraulic and pneumatic packings, as well as a complete line of hydraulic oils and fluids.

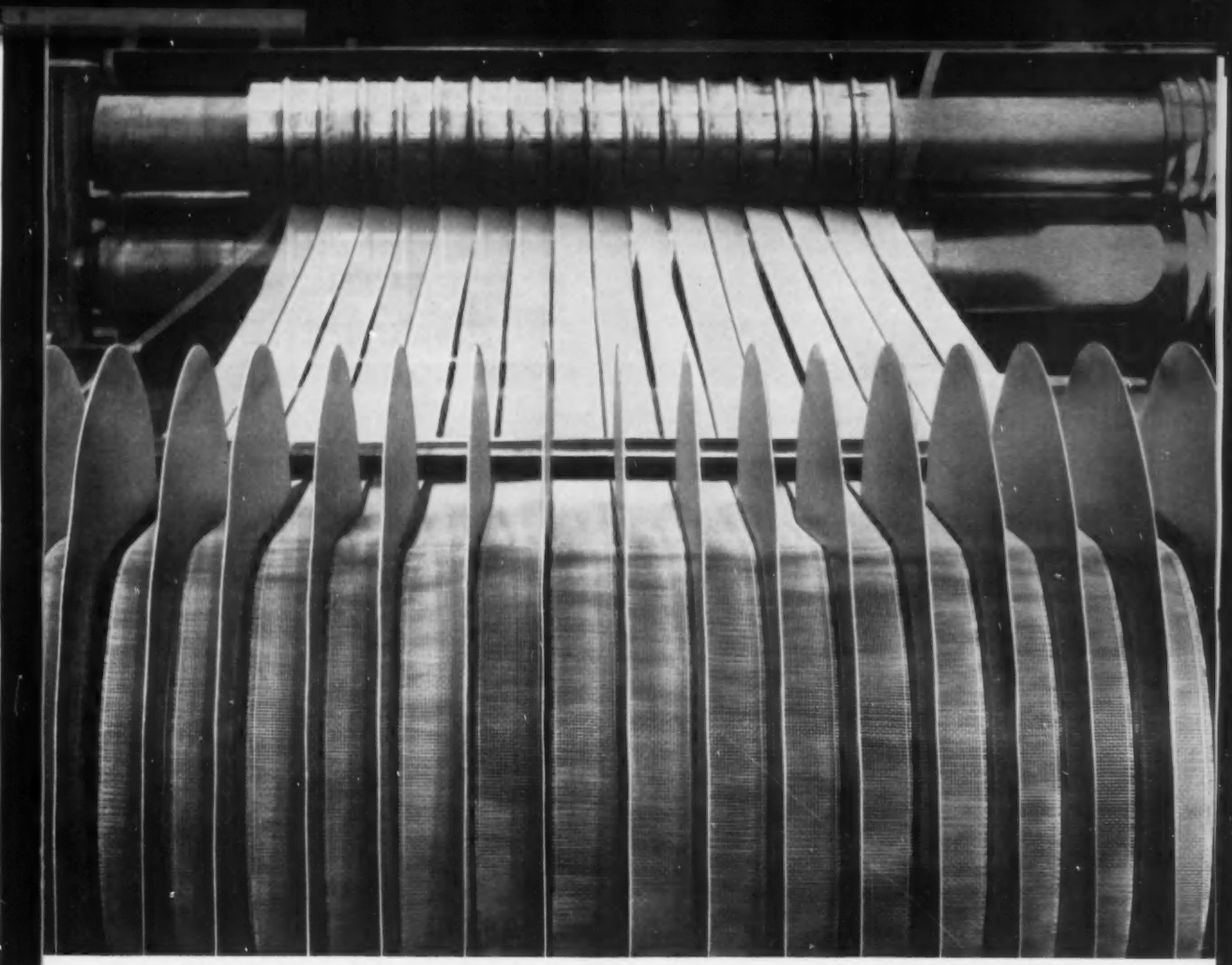
Standardize on Houghton. You'll get the newest first—and the best always. Call your Houghton Man and let him explain Houghton's Hydraulic Service. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

. . . products of

E F HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .



HOW WE GO TO ANY LENGTH...OR WIDTH...

to help you save money on wire cloth components!

● Wire cloth users are experiencing a couple of new reasons why it pays to do business with the Reynolds Wire Division of National-Standard.

Here's the idea. . . .

In blanking or forming wire cloth components, a roll of wire cloth 2 to 8 times normal length means 2 to 8 times as much production in a single run without a shutdown. It also means less waste and less handling!

Similarly, when cloth is pre-slit (as shown above) to exactly the width a customer really needs, this too results in less waste, faster production and reduced handling.

So these days Reynolds Wire is departing more and more from old established industry standards . . . producing wire cloth in continuous lengths up to 800 feet instead of standard 100-foot rolls . . . and furnishing pre-slit cloth as narrow as 1 inch wide and even less.

Why not talk with Reynolds about your wire cloth needs? If we can help you cut production costs you'll be ahead on *every* count...for there's no better, more uniform wire cloth than that you can get from Reynolds. Try us.

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape

ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth

NS
NATIONAL-STANDARD Company
NILES, MICHIGAN

WAGNER LITHO MACHINERY • JERSEY CITY, N. J.
Special Machinery for Metal Decorating

WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

DESIGN ENGINEERS...

NOW!

Take the guesswork out ...with Silicone Rubber!

If you have a heat, cold, electrical, flexibility, or other problem in your design and engineering work—you may well find the answer in UNION CARBIDE Silicone Rubber Compounds.

They offer phenomenal flexibility at low temperatures, thermal and oxidation stability at high temperatures, ozone resistance, abhesiveness, resistance to weathering, and good electrical and oil resistance.

These specially compounded general purpose elastomers—all of which meet or exceed Aeronautical Materials and A.S.T.M. specifications—provide *predictable curing results!*

They can give the desired low compression set over a wide range of hardnesses, for example, or exceptional high-pressure steam resistance, or the thickest section cures ever achieved without delaminating, sponging, or blowing.

They give you a new tool in controlling many properties of silicone rubber products in respect to hardness and elongation. Catalyst residue and its associated problems virtually reach the vanishing point.

Think of them in terms of your unsolved problems for cable and wire extruded coatings, for tapes, gaskets, motor mounts, or even for steam irons, stove parts, freezers. Then call in a UNION CARBIDE Silicone specialist and outline your problems. Call our nearest office or write Dept. P-6.

Look to Union Carbide for Silicones

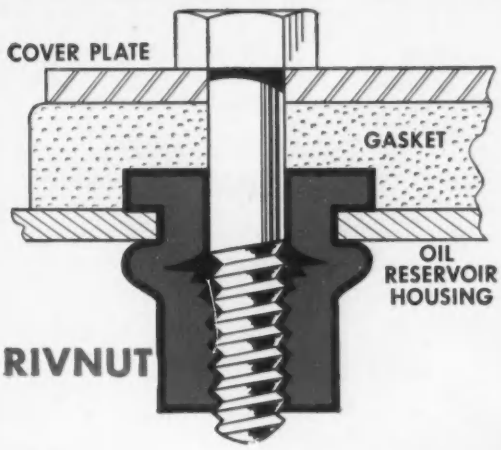
SILICONES DIVISION

UNION CARBIDE
AND CARBON CORPORATION
30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited
The term "Union Carbide" is a trade-mark of Union Carbide and Carbon Corporation

B.F.Goodrich RIVNUTS

save time, cut costs by eliminating welding, tapping, cleaning



OLD WAY

1 Weld 4 nut plates to inside of housing
2 Drill
3 Tap
4 Clean
5 Attach cover with bolts

WITH RIVNUTS

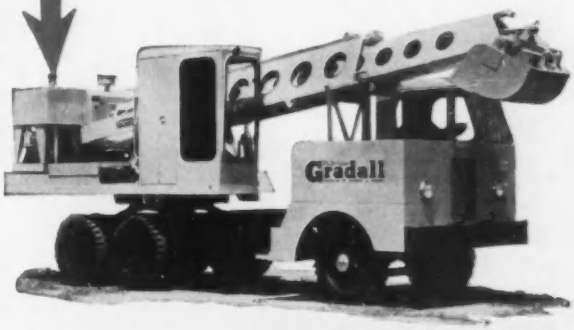
1 Punch holes in housing
2 Insert Rivnuts and upset
3 Attach cover with bolts

B. F. GOODRICH RIVNUTS cut costs and speed assembly by providing a firm, accurate nutplate in one operation!

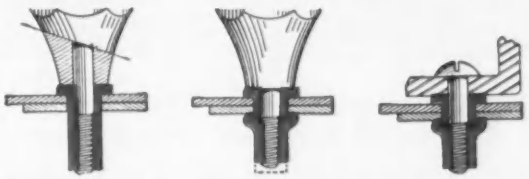
This fastening job on Warner & Swasey's Multi-Purpose Gradall used to take five operations. Oil reservoir housings had to be detoured from the assembly line to weld four nutplates on the inside. Then they were drilled, tapped and cleaned before the cover could be attached. By switching to Rivnuts, welding, tapping and cleaning were eliminated.

Now one worker installs Rivnuts from one side in seconds. Assembly flow is straightline. Fastening time is cut in half.

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs and eliminated costly steps. They can do the same for you. Get more information or engineering help by writing: *Rivnut Sales, B. F. Goodrich Tire & Equipment Company, a Division of The B. F. Goodrich Company, Akron, Ohio.*



HOW RIVNUTS PROVIDE AT LEAST 6 CLEAN THREADS IN ONE SIMPLE OPERATION:



1 Rivnut is threaded onto pull-up stud of heading tool, then inserted.

2 Tool lever operates pull-up stud forming a bulge in the Rivnut shank.

3 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

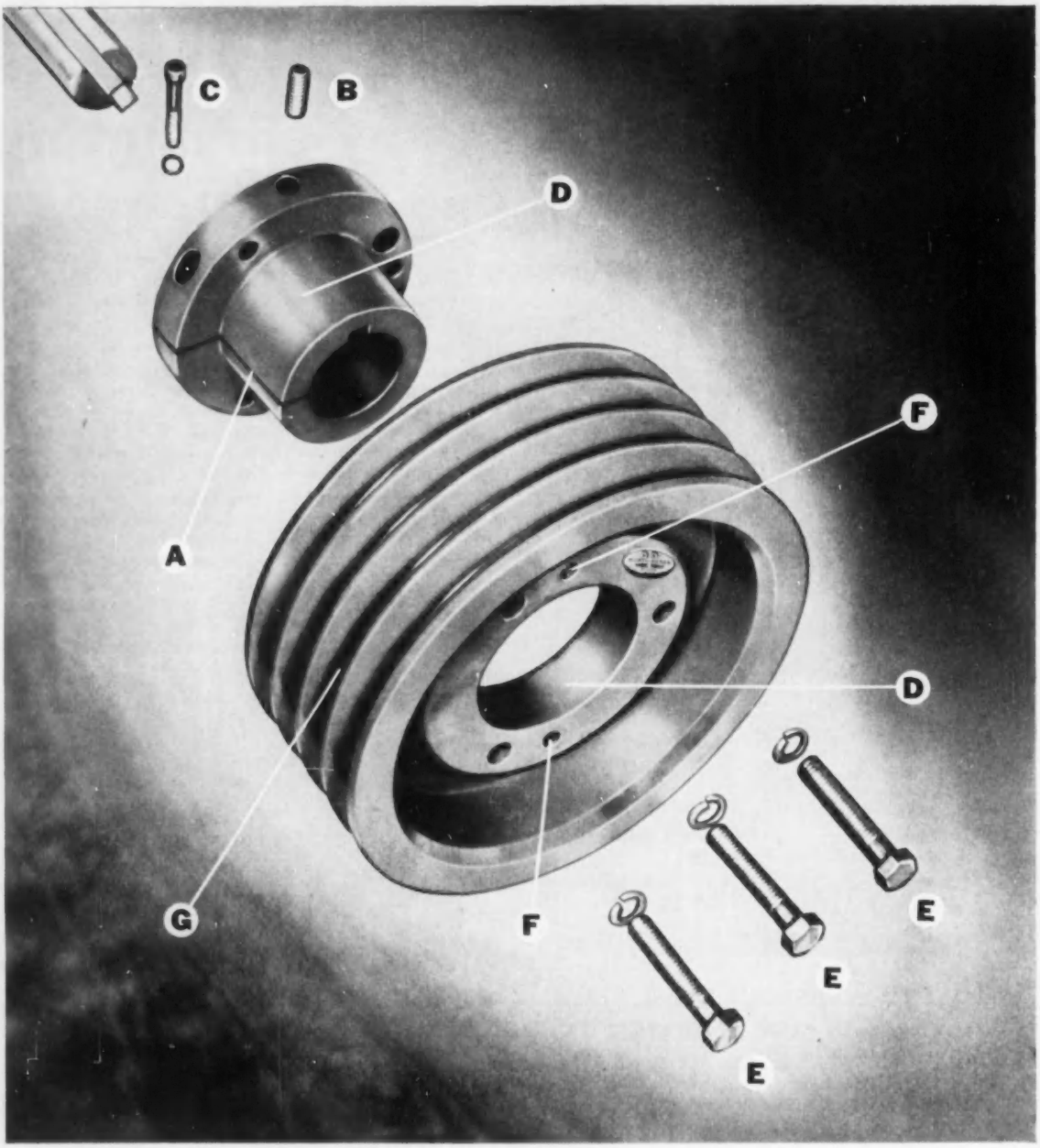
RIVNUT

THE ONLY ONE-PIECE BLIND RIVET WITH THREADS

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy by writing to: The B. F. Goodrich Co., Dept. PE-66, Akron, Ohio.

Again in '55, industry's



Exclusive design. All Worthington QD sheaves have these outstanding product features:

A - Completely split QD hub holds shaft tightly under heaviest shock loads.

B - Cup point set screw* in QD hub keeps shaft key in position.

C - Clamp screw* secures hub in proper alignment on shaft when mounting sheave.

D - Tapered fit between hub and sheave allows easy-on, easy-off, hold-tight action.

E - Pull-up bolts draw sheave on to hub to produce positive fit on shaft.

F - Tapped holes in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.

G - Groove cross-sections are accurate and uniform so that each V-belt seats properly, pulls evenly.

**All Worthington-manufactured QD heavy duty hubs incorporate these exclusive features*

best selling sheave

9 outstanding features make Worthington QD the favorite of design engineers

According to authoritative industry figures, more QD sheaves were sold last year than any other type. Design engineers tell us they prefer the QD —the original two-piece design—because of these 9 outstanding features:

1 EXCLUSIVE DESIGN. As shown at left, Worthington QD sheaves have many outstanding product features which mean real benefits to all users.

2 EASY TO INSTALL AND REMOVE, the QD's tapered hub slides on shaft, locks with a cap screw for permanent alignment. Sheave slides on hub and pulls up with three big bolts for tight holding. Comes off just as easily.

3 BALANCED PERFORMANCE of Worthington Multi-V-Drives, due to accurate uniform grooves and precise mating (with Worthington-Goodyear V-belts), gives you even tension, even pull, even speed, even wear, less vibration.

4 SMART APPEARANCE. The QD sheave's scientific design not only provides more efficient transmission of power but actually adds to the looks of your product.

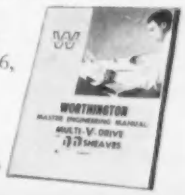
5 QUICK DEPENDABLE SERVICE—factory-warehouses back distributors.

6 MATCHES YOUR QUALITY STANDARDS. QD sheave quality stems from extremely accurate balance, tough close-grained semi-steel metal, rigid inspection for minimum tolerances, and "I-beam" arm construction of driven sheaves which gives greater strength with less weight.

7 WIDE RANGE OF SIZES with factory-warehouse stocks covering over 100,000 V-belt drive combinations from ½ to 600 hp.

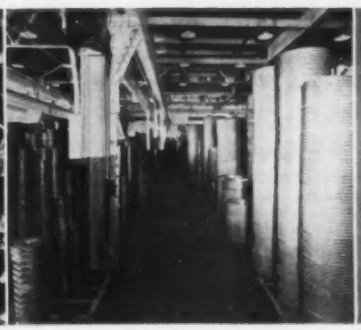
8 WIDE RANGE OF APPLICATIONS. QD sheaves have been job-tested and accepted on every class of equipment and in every industry. Some of the many applications in which QD sheaves have given outstanding performances include: blowers, boring mills, compressors, conveyors, crushers, elevators, grinders, lathes, stokers, oil field machinery and many, many others.

9 COMPLETE ENGINEERING DATA—yours for the asking. In Worthington's 100-page manual, tabbed, easy-to-find tables enable you to select the right sheave and V-belt combination for any job in only three minutes. For your free copy write to Section MV66, Worthington Corporation, Oil City, Pa. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont.



MV.6.6

Over 400 stock Worthington-Goodyear V-belt sizes.



Over 100,000 drive combinations available from warehouse stocks.

13 factory-warehouses back more than 250 distributors.

WORTHINGTON

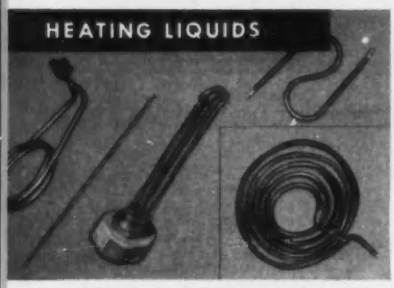
SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

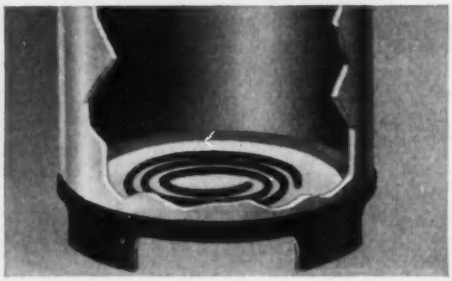
DESIGNING HEAT INTO YOUR PRODUCT?

G-E Heaters Can Be Formed to Your Exact Design; Big Selection Saves You Design and Production Time

HEATING LIQUIDS



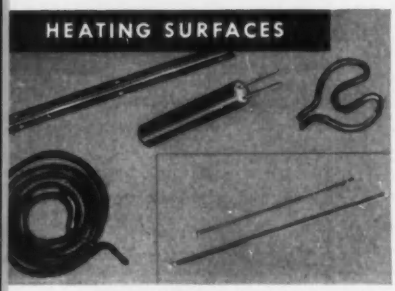
1 **SIMPLIFIED DESIGN** and easy installation benefit maker of cement tester, who chose sturdy, flexible G-E tubular heaters.



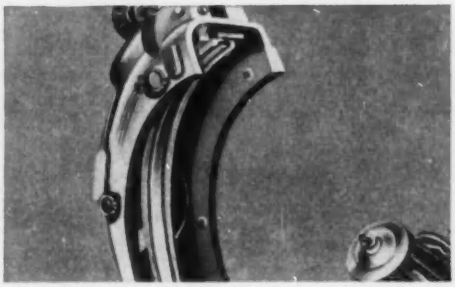
2 **SPACE LIMITATION** is easily overcome with General Electric tubular heaters, which can be formed readily to practically any shape . . . without danger of breaking.

3 **G-E TUBULAR HEATERS** simplify tester use. To begin test, operator need only plug in tester, load specimens, and turn on switch.

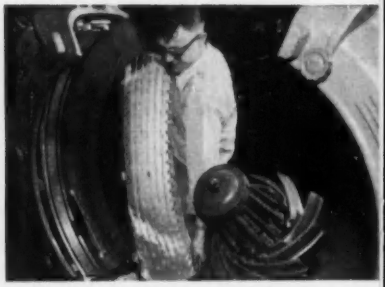
HEATING SURFACES



1 **FLEXIBLE BUT RUGGED** G-E tubular heaters are chosen by tire-retreader manufacturer after test. Other makes broke when formed.

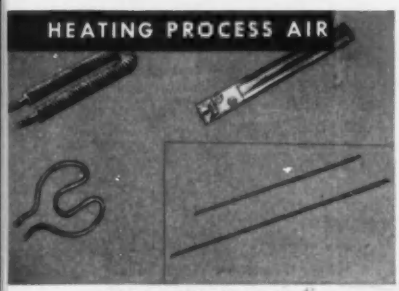


2 **GENERAL ELECTRIC** tubular heaters bend easily to the curved shape of tire retreader. Heaters are inserted into grooves in heating plate to gain maximum heat transfer.

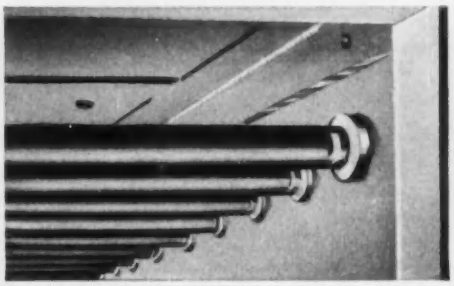


3 **EXACT HEAT** required for top-quality retreading of huge truck tires is achieved with high-efficiency General Electric heaters.

HEATING PROCESS AIR



1 **RAPID INSTALLATION** is one benefit of uncomplicated design. Designer used straight-length tubular heaters in pre-heat oven.



2 **COMPACT DESIGN** of pre-heat oven is possible with inside-mounted General Electric tubular heaters, which replaced outside, top-mounted heaters formerly used.

3 **UNIFORM HEAT** throughout oven combines radiation and convection, since tubular heaters are mounted inside oven chamber itself.

Section B723-9, General Electric Company,
Schenectady 5, N. Y.

Name .....

Company .....

Street .....

City ..... State .....

FREE

60-page Catalog of General Electric heaters and heating devices—describes full line. Also provides helpful application data. GEC-1005G.

GENERAL ELECTRIC

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 27

3 Year Test Proves Superiority Of Silastic Gaskets On Steam Cookers

Despite prolonged exposure to steam and pressure, Silastic*, Dow Corning's silicone rubber, keeps its shape, remains resilient, maintains an efficient seal. That's why the Cleveland Range Co. uses gaskets made from Silastic for sealing the doors of its well-known line of Steam-Chef Steam Cookers.

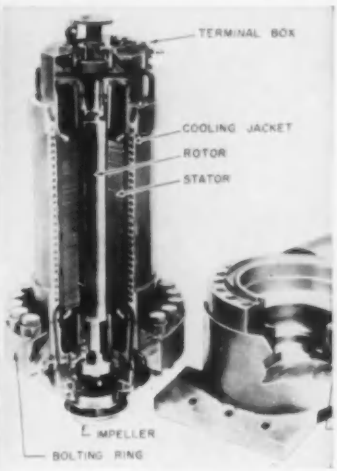
The change from organic rubber to Silastic was made after a three year field test program which proved the superiority of silicone rubber gaskets. Molded by the Ohio Rubber Co., these test gaskets were installed on Cleveland Range units in commercial and institutional kitchens throughout the midwest.

Restaurant managers were surprised to see at the end of six months, the average life of organic rubber gaskets, that the Silastic gaskets still looked as good and sealed as efficiently as when new. Time and rugged service apparently had little or no effect on the silicone rubber gaskets. Particularly impressive was the fact that Silastic did not absorb food oils or impart off-flavor taste to foods during cooking.

This photograph of a Steam-Chef Cooker in the Mill Restaurant, Cleveland, Ohio, shows the type of evidence compiled during this test. The

(cont'd. pg. 2)

* T. M. REG. U. S. PAT. OFF.



CANNED MOTOR-PUMP HANDLES RADIOACTIVE LIQUID COOLANTS

Utilizing the thermal stability of electrical insulation made with Dow Corning silicones, Westinghouse designers have developed a canned motor-pump that answers the Atomic Energy Commission's need for a way to circulate radio-active liquid coolants at temperatures up to 650 F in hermetically sealed hydraulic systems.

Used in the primary coolant system of nuclear reactors, both the pump impeller and its electric drive motor are encased in a single pressure-tight vessel. The hot, radioactive fluid circulates around the bearings, rotor and stator of the silicone insulated drive motor.

Stainless steel jacketing protects the ends and outside diameter of the stator windings. A thin, leak-tight, nickel-alloy cylinder or "can" lines the inner bore of the stator. The outer surface of the rotor is similarly canned.

Silicone-insulated canned motor-pumps of this design are now available in capacities

(cont'd. pg. 2)

Liquid Springs Use Silicone Fluid For Greater Efficiency

With compressibility of 9 to 10% at 20,000 psi compared to 6 or 6½% for mineral base oils, silicone fluids are specified by designers at Wales Strippit Corporation as the compressible media for their entire line of liquid filled "Hydra Springs."

Thermal stability and remarkably flat viscosity temperature slopes were also important considerations which led to the use of Dow Corning silicone fluids in these precision hydraulic devices. Most Hydra Springs employ Dow Corning 200 Fluid. A few, requiring special springing characteristics, utilize other Dow Corning silicone fluids.

Providing forces 3 to 6 times greater than coil springs of equal size, Hydra Springs have proved highly efficient and successful in metal working, dies, perforating equipment, testing equipment, ordnance devices, specialized machinery. ***No. 268***

Liquid spring at right delivers same amount of force as the large cumbersome metal coil spring.

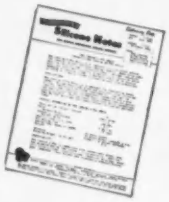
CLASS H MOTOR STILL ON TEST AFTER 56,715 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A.M. May 1, 1956, this motor was still on test after 56,715 hours at an average copper temperature of 240 C! That's equivalent to 344 years operation at the Class H temperature of 180 C.

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Dow Corning Z-4141, an easily applied silicone treatment for glass surfaces, imparts a high degree of scratch resistance and reduces breakage. Effective at low concentrations on bottles and containers, light bulbs and tubing, camera lenses, and artware. *No. 273*

"Potting Gives Maximum Reliability", an article from ELECTRONIC EQUIPMENT, describes the method of encapsulating a new series of electronic devices developed by the Naval Ordnance laboratory. Using silicones helps to provide the utmost protection against mechanical and thermal shock, vibration, and humidity. *No. 274*

Now available—1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12-page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment, or reducing production and maintenance costs. *No. 275*

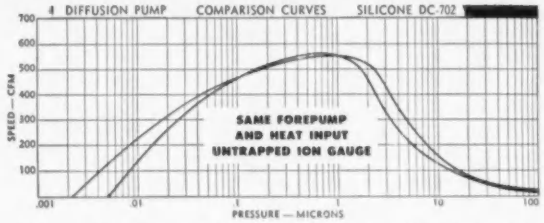
Silicone-Glass Laminates for electrical and mechanical applications are described in new brochure which illustrates parts used in typical industrial applications. Also lists engineering information on properties of silicone-glass laminates and lists fabricators of such laminates. *No. 276*

Dow Corning 510 Fluids are unsurpassed as damping media for instruments and other devices required to give uniform performance from —70 to over 400 F. Excellent dielectric properties plus relatively constant viscosities make these silicone fluids particularly adaptable to electrical and electronic equipment. *No. 277*

Documentary film "What's a Silicone?" available free of charge for showings to technical audiences in every industry. In full color and sound, this dramatic 16mm film allows you to see Dow Corning silicones in action improving the performance of products ranging from nursing bottle nipples to diesel locomotives. For more information about this educational film and how to arrange a showing for interested persons in your plant, circle ..... *No. 278*

Speed And Range Of Vacuum Pump Increased With Silicone Fluid

A series of tests conducted by the F. J. Stokes Machine Company, Philadelphia, world's largest producer of high vacuum equipment, prove that Dow Corning 702 Diffusion Pump Fluid helps to attain higher vacuum in less time than possible with organic fluids.



As indicated by the curve, the silicone fluid provides faster evacuation in the 1 to 10 micron range and at the same time assures lower ultimate pressures in the range between .01 and .001 microns.

The tests were performed in connection with development of Stokes' new line of Ring-Jet Diffusion Pump Series 160, and Ring-Jet Booster Pumps Series 150. Remarkably effective for rapid-cycle work, these pumps are available in 5 sizes from 4 to 16 inches.

The test results, since confirmed by experience in other Ring-Jet Pump models, have led Stokes to advise its representatives "since the organic fluid is almost the same in price as the silicone, the silicone fluid (Dow Corning 702) would be preferable, especially considering that it will not oxidize when subjected to the atmosphere at high temperatures." *No. 271*

Silastic Impregnated Sleeving Insulates Lead Wire in Strip Heater

Braided glass sleeving impregnated with Silastic, Dow Corning's silicone rubber, retains excellent flexibility and insulating effectiveness at temperatures that cause rapid failure of organic electrical insulating materials. The advantages of such sleeving are demonstrated in the small strip heaters manufactured by Watlow Electric Co., of St. Louis.

Not much larger than elbow spaghetti, these efficient 175 watt heating units are used by aircraft builders and other metal working companies to heat aluminum during dimpling or countersinking to provide flush mounting of rivets. Most aluminum alloys cannot be formed cold without setting up stresses.

Slipped over the dimpling die-tips, the heaters produce temperatures of 500 F and higher. The lead wires flex continually with movements of the die. To protect the lead wire with a high dielectric strength material that retains good flexibility at high temperatures, Watlow uses Turbo 117, a Silastic impregnated sleeving fabricated by The William Brand Co. Watlow reports silicone insulated sleeving has substantially reduced lead wire failures. *No. 272*

MOTOR-PUMP *(continued)*

from 5 to 17,000 gpm. They can handle high temperature liquids at system pressures up to 2500 psi.

According to Westinghouse, these pumps are also used in steam systems where controlled or forced circulation is required, and in certain process applications of the chemical and petroleum industries. Special canned motor-pumps are even available for pumping molten metal at temperatures as high as 1000 F. *No. 269*

COOKER GASKET *(continued)*

organic rubber gasket on lower door, hardened and flattened by heat and pressure, has completely lost its sealing efficiency. The narrow Silastic gasket on the top door is as effective as new after the same length of service. *No. 270*

Dow Corning Corporation, Dept. 6606, Midland, Michigan

Please send me: 268 269 270 271 272
273 274 275 276 277 278

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND

first in silicones

DOW CORNING SILICONES

CORPORATION MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

new from PET

output shaft can be rotated to operate in any 90° quadrant.

A LIGHTWEIGHT, COMPACT F.H.P. MOTOR

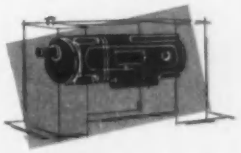
. . . *power plus versatility*

Versatility is the keynote of this new PET Universal Motor, now being used as a starter unit on Briggs and Stratton gas engines. The output shaft can be rotated to operate in any 90° quadrant. The motor can be mounted to perform in any position or angle . . . either foot mounted on integrally cast pads or flange mounted on machined rabitt diameter, front portion gear case housing. Easily accessible terminals make connection fast and simple. Flexible grounded or ungrounded line cord optional. Designed for either intermittent or constant duty, this flexible motor can be furnished with output speeds from 1125 to 27,000 R.P.M. and with horsepower ratings ranging from 1/10 to 1/3. Double reduction gear systems are available with gear ratios up to 24:1.

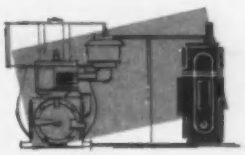
Simple variations enable this motor to meet a wide range of different needs. Special gearing, shafts, and dimensions can be easily supplied. Governor control is available up to 10,000 RPM speed.

This really versatile FHP motor was produced only because PET's engineers have become accustomed to solving a vast variety of fractional horsepower problems. Recommended applications include use as an engine starter, garage door lift motor, electrical tool motor, power source for tool room, milling machine, and in a variety of other industrial equipment.

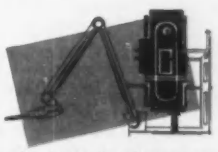
all angle operation



used as power source to raise and lower garage doors.



used as starter on gasoline engine with output shaft at straight angle or in horizontal position depending on type of engine.



used in inverted position as power source for tool room milling head.

SPECIFICATIONS (SERIES 1200)

- Universal type AC/DC Series, or Shunt Wound
- Output speeds; 1125 to 27000 rpm
- Voltages; AC, 24 to 230V; DC, 6 to 230V
- Bearings—bronze sleeve; ball, or needle optional
- Size; Geared Motor 2¾ x 2¾ x 6½
  Without Gear Housing—2¾ x 2¾ x 5
- Ventilated or totally enclosed

PET® POWER TOOLS

PORTABLE ELECTRIC TOOLS, INC.
Special Products Division
320 West 83rd Street
Chicago 20, Illinois

for full details mail coupon today

PE 6-56

Special Products Division
PORTABLE ELECTRIC TOOLS, INC.
320 West 83rd Street, Chicago 20, Illinois

Gentlemen:

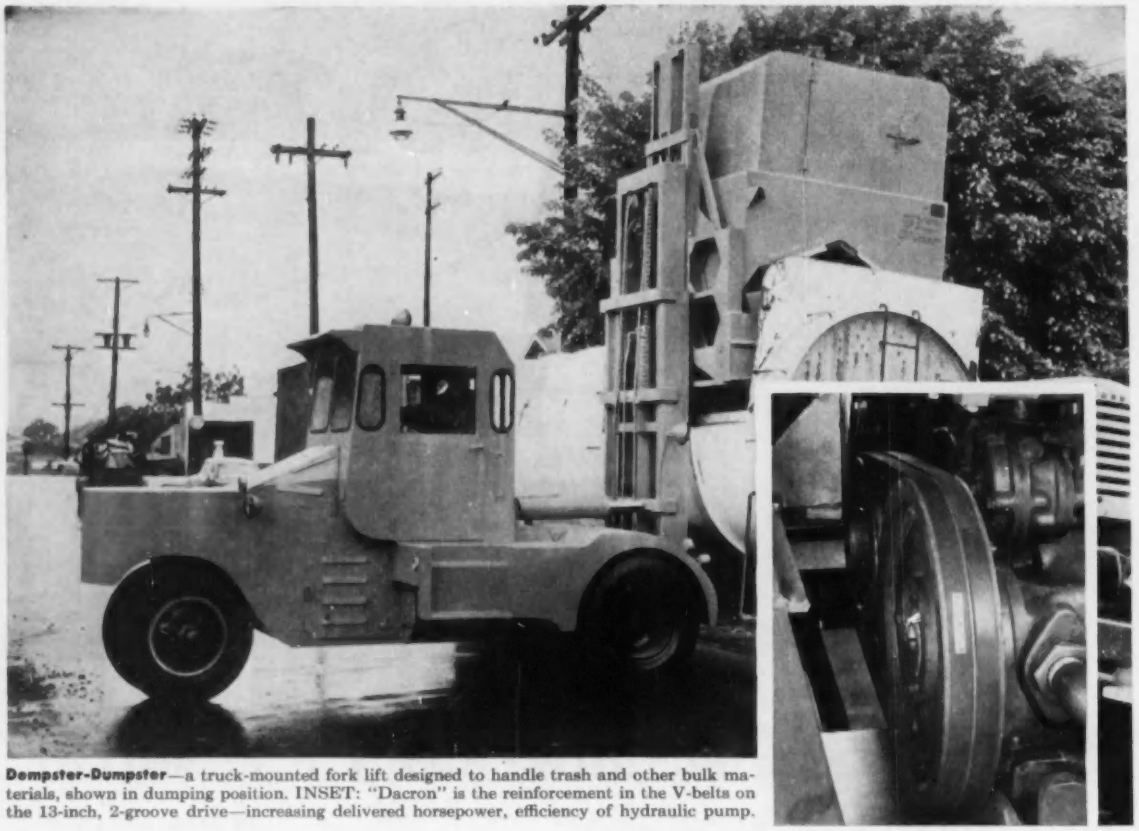
Please mail me complete FREE information on PET's complete line of fractional motors and motor parts.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



Dempster-Dumpster—a truck-mounted fork lift designed to handle trash and other bulk materials, shown in dumping position. INSET: "Dacron" is the reinforcement in the V-belts on the 13-inch, 2-groove drive—increasing delivered horsepower, efficiency of hydraulic pump.

How the Dempster-Dumpster's V-belt drive efficiency was increased by premium V-belts reinforced with DACRON

REG. U.S. PAT. OFF.

The lifting and steering power of the Dempster-Dumpster generates from a single hydraulic pump driven by V-belts. To insure dependable, slip-free operation and positive starting at this important spot, Dempster Brothers, Inc., switched to premium V-belts reinforced with Du Pont "Dacron"* polyester fiber. During the six years since the change, the belts have been proving their superiority on hundreds of Dempster-Dumpsters in use throughout the country.

Slippage and stretching have been sharply reduced by the 40% greater strength of belts made with Du Pont "Dacron". Two premium V-belts now do the work formerly handled by three standard belts. The belts remain stable . . . deliver more horsepower from the pump. And the ability of these belts to withstand greater shock loading assures fewer replacements, more efficient, trouble-free operation.

In designing *your* next drive, investigate the advantages of premium V-belts made with "Dacron". They combine the unique properties of the "Dacron" yarn made by Du Pont and the highest skills of the leading V-belt manufacturers. For a list of manufacturers using "Dacron" in premium V-belts, write to E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Wilmington 98, Delaware. Premium V-belts shown in above photo were manufactured by the U.S. Rubber Company.

6 REASONS FOR USING PREMIUM V-BELTS REINFORCED WITH "DACRON"

- Transmit up to 40% more horsepower.
- Withstand greater shock loading.
- Longer flex life.
- Cut downtime.
- Low stretch.
- Require less maintenance.

***"Dacron"** in V-Belts* DU PONT

REG. U. S. PAT. OFF.

REG. U.S. PAT. OFF.

**"Dacron" is Du Pont's registered trademark for its polyester fiber.*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

This combination of features is EXCLUSIVE with . . .

SEALMASTER

BALL BEARING UNITS

. . . they are

IMPORTANT TO YOU!

Write for your copy of Bulletin 454 today!

The products you design today to meet the demands of tomorrow must be carefully engineered right down to the smallest component. The product must be geared to the demands of an "automation minded" world and the competition of the years ahead. Production schedules can't be kept up when machinery is down for maintenance. No component you can build into your products will mean more to its efficient performance than the bearing units carrying the load. The exclusive combination of features found only in SEALMASTER self-aligning, pre-lubricated Bearing Units are important to your product's continuous performance and acceptance.

SEALMASTER

BALL BEARING UNITS

SEALMASTER BEARINGS

A DIVISION OF STEPHENS-ADAMSON MFG. CO., 9 RIDGEWAY AVE., AURORA, ILLINOIS

New trends and developments in designing electrical products . . .

How to determine which General Electric Alnico Permanent Magnet grade offers the optimum set of magnetic and physical properties for a particular application

THE BASIC function of a permanent magnet is to provide a specific magnetic flux across a given air gap. The basic problem for the designer is to select a magnetic material with the optimum combination of magnetic and physical properties to fulfill this function.

Since the permanent magnet has considerable influence on the final size, cost, and efficiency of the product, it is important to know the primary characteristics of each of the seven available General Electric Alnico grades.

Each of these grades offers specific advantages in available energy, unit cost, and physical properties. No one grade excels in all of them.

In terms of energy product, cast Alnico 5 has no peer among magnetic alloys. Its 5 million minimum gauss-oersteds is 43% higher than Alnico 6.

Its demagnetization curve (Figure 1) shows that Alnico 5 has the highest residual induction of all the Alnicos, as well as relatively high coercive force. This means that a smaller cross-sectional area and less total volume will be required to maintain a given air gap density.

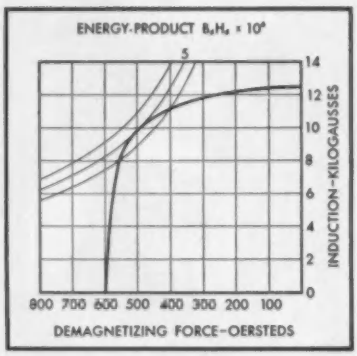


Fig. 1 — Alnico 5 Energy Product and Demagnetization Curves

Thus, where there are space restrictions, as in hearing aids, Alnico 5 has more available energy per unit volume. Where there are weight restrictions, as in airborne magnetrons, Alnico 5 offers more available energy per pound. And where there are cost considerations, as in loud speakers, Alnico 5 provides maximum external energy per dollar.

At the opposite extreme, Alnico 3 has one of the lowest energy products of the Alnicos – 1.38 million gauss-oersteds (Figure 2). About 3½ times more Alnico 3 than Alnico 5 is required to produce a given air gap field energy requirement.

However, because of its lower cost, Alnico 3 offers important savings in applications like toys and novelties, where performance and weight are not critical factors.

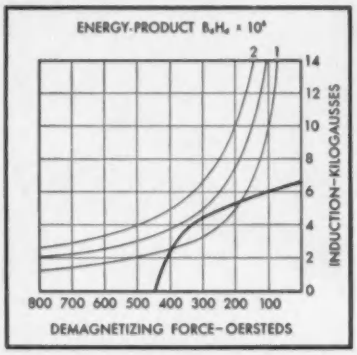


Fig. 2 — Alnico 3 Energy Product and Demagnetization Curves

Despite its relatively low energy product, Alnico 3 still provides more external energy, at lower cost, than does 37% cobalt steel – the best of all the magnet steels.

G-E Alnico 6 has an energy product of 3.5 million gauss-oersteds, ranking second only to Alnico 5. But the primary advantage of this grade lies in its flatter, more stable demagnetization curve (Figure 3, see top of next column).

Alnico 6 has ability to provide useful field energy under dynamic operating conditions. And in certain applications, Alnico 6, despite its lower energy product, will produce a higher gap flux density than Alnico 5.

For motors, generators and lifting applications, where the magnet is operating under varying demagnetizing influences, Alnico 6 offers greater stability and high useful recoil energy.

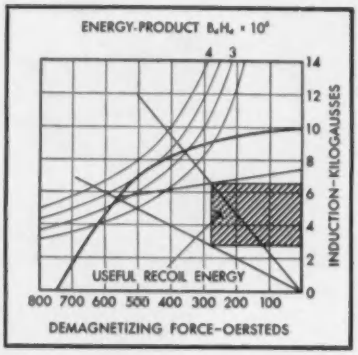


Fig. 3 — Alnico 6 Energy Product and Demagnetization Curves

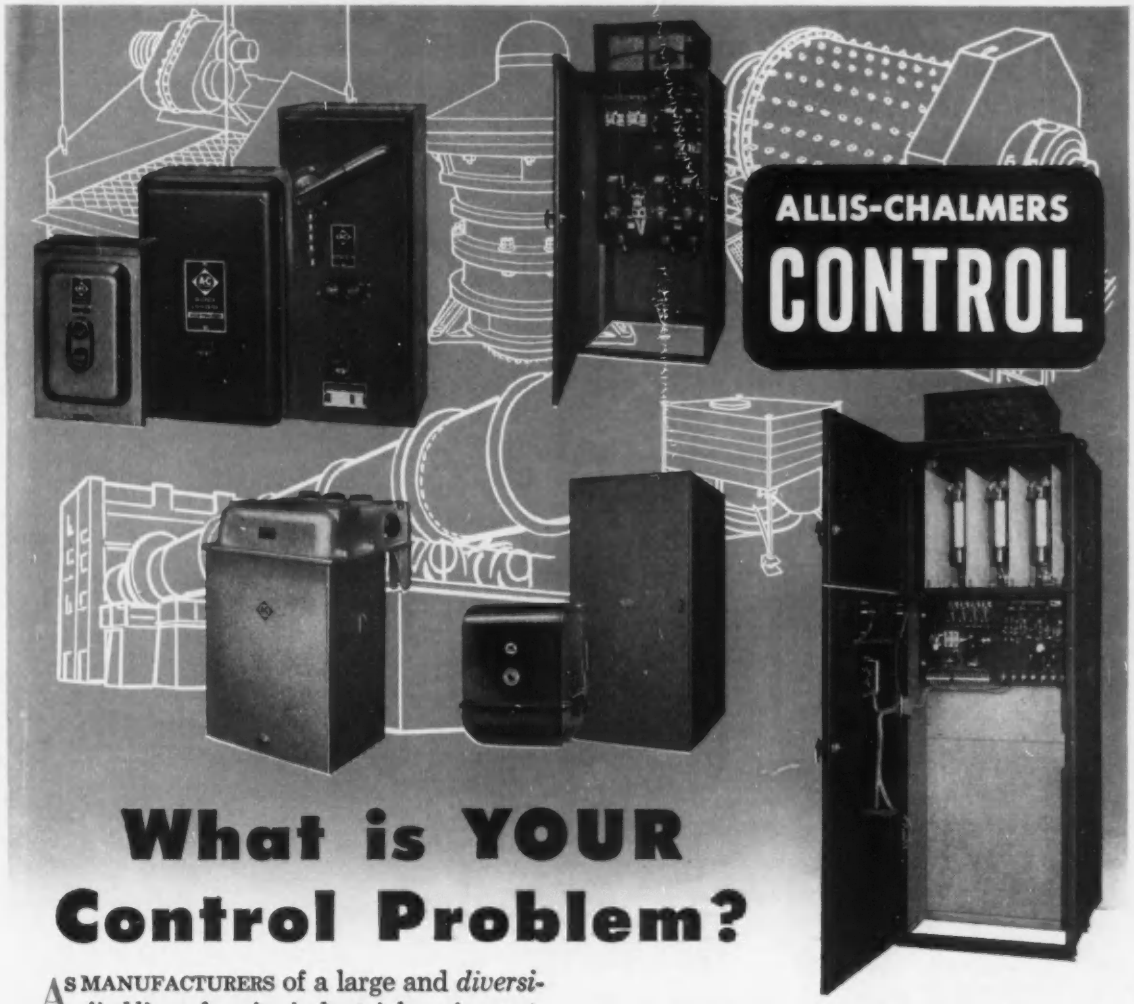
Generally speaking, permanent magnets' physical properties are seldom the primary consideration when selecting magnetic materials. However, in certain high rotary speed applications, such as rotors, physical strength is of major importance. This necessitates the use of a sintered, instead of a cast, Alnico grade. These sintered magnets have tremendously improved physical properties, with but a slight sacrifice in magnetic properties.

Sintered Alnico 2, for example, has more than 20 times the tensile strength of cast Alnico 2. And, it has 10 times the transverse rupture strength, in addition to more uniform magnetic properties. Approximately the same order of structural improvements holds true for sintered Alnicos 4 and 5.

Selecting the proper magnetic material is a crucial and complex part of the design problem. If you would like the assistance of a G-E Magnet Engineer in this, or any other, stage of your permanent magnet design, write: *Carboloy Department of General Electric Company, 11127 E. 8 Mile Ave., Detroit 32, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC



What is YOUR Control Problem?

AS MANUFACTURERS of a large and *diversified* line of major industrial equipment, Allis-Chalmers has been called upon to solve thousands of control application problems in practically every industry. This specialized experience in coordinating power utilization is *yours* when you specify Allis-Chalmers control.

Control for every ac application

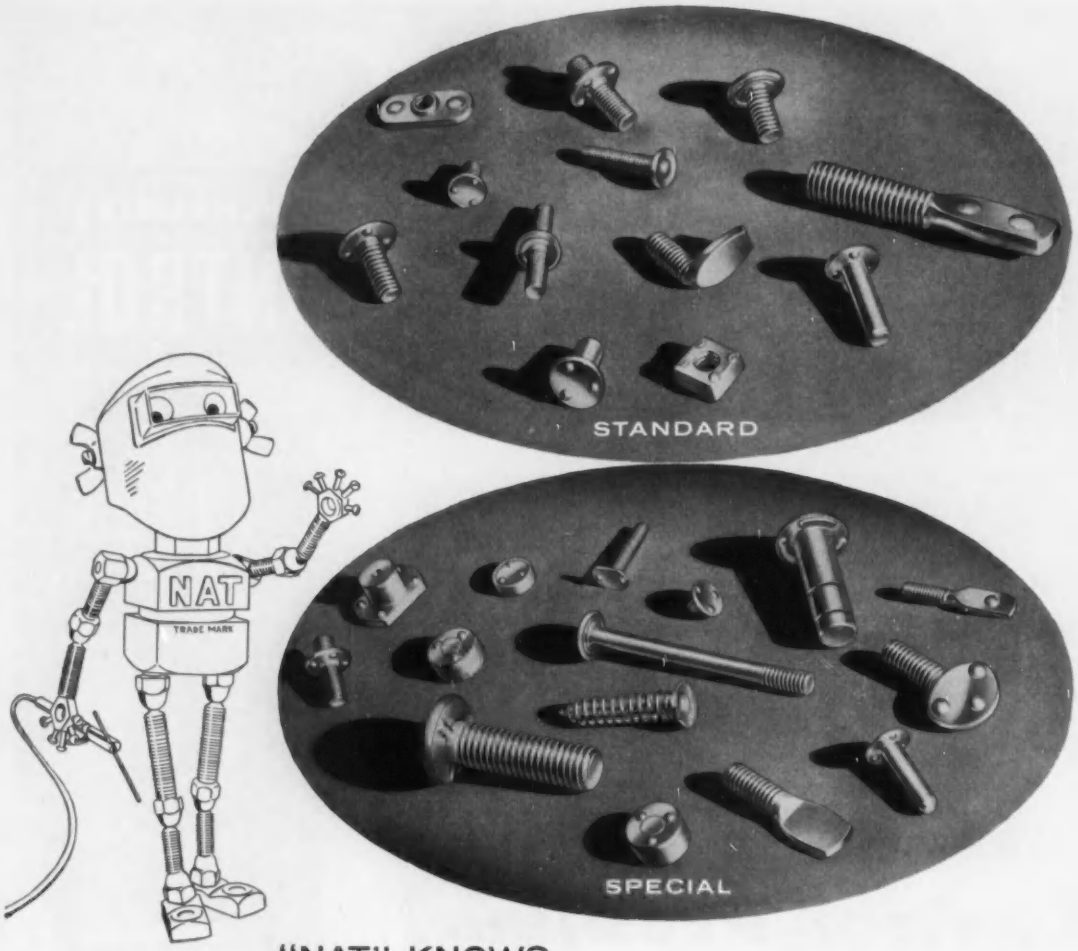
Allis-Chalmers offers an extensive line of manual and magnetic control to meet every condition of motor operation. Control functions, varying with specific job requirements, include full or reduced voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking.

Custom protection

Built into all Allis-Chalmers control is the type and degree of protection dictated by the application. Controls are available in general purpose and special cabinet, including water-tight, dust-tight and explosion-proof enclosures. A-4516

For complete information on any specific control problem, call your nearby Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wis.

ALLIS-CHALMERS



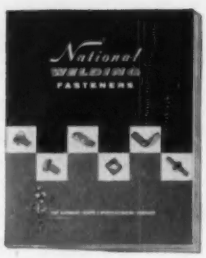
"NAT" KNOWS

WELDING FASTENERS

Standard or special, "Nat" can tell you all about projection welding fasteners. National's complete, high quality line of standard weld screws, pins and nuts gives you maximum strength and 100% optimum welds . . . even on materials .030 to ¼ inch thick.

Bring your welding fastener problems to National. Besides offering a satisfactory solution, we will design any *special* welding fastener you may need.

Write for *National Welding Fasteners* catalog. It shows "Nat's" complete welding line.



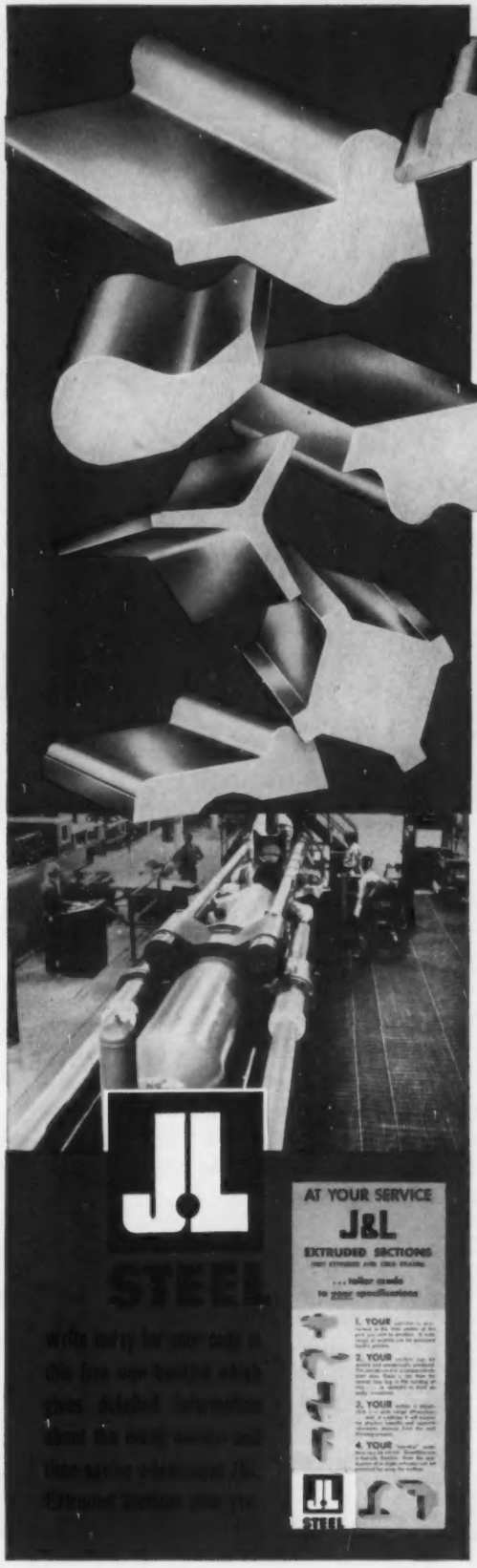
THE NATIONAL SCREW & MFG. COMPANY

CLEVELAND 4, OHIO

Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.

National PRODUCTS

Fasteners Hodell Chains Chester Hoists



J&L CUSTOM-MADE HOT EXTRUDED COLD DRAWN SECTIONS

...boost production, cut over-all costs

Progressive industry is today utilizing J&L's Custom-Made, Hot Extruded Cold Drawn Steel Sections to:

1. **Eliminate time and costs** in machining and finishing operations
2. **Reduce scrap losses** practically to the zero point
3. **Eliminate the cost of castings and forgings** of intricate sections requiring considerable machining
4. **Reduce inventories** due to their quick availability from the J&L plant

These sections can be extruded and cold drawn to the exact specifications of the parts you require—in any quantity you specify. Even the production of a single extrusion can be economical. Obtainable in a wide range of analyses, J&L Extruded Sections can be produced in a large variety of shape profiles—even many of those that cannot be hot-rolled are practical.

The physical benefits of J&L Extruded Sections are equal to or greater than those derived from the cold drawing process, and tolerances are as accurately maintained. The excellent surfaces of these Extruded Sections require little—if any—finishing operations.

Send us your inquiry for prompt and efficient J&L service.

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 409
Pittsburgh 30, Pa.

Please send me your new Booklet on *Extruded Sections.*

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

Because of cord capers like this...

KINK IT...

DRAG IT...

You need rugged G-E CORDS to help

The General Electric line of cords offers a wide variety of types and constructions: flame-resistant, moisture-, and weather-resistant; cords insulated with asbestos, silicone rubber, and other special materials designed to withstand special conditions. Because of the wide selection, you'll find a G-E cord engineered to meet the uses and abuses of almost every application.

General Electric application engineers have assisted many product designers and manufacturers on application problems. They can help you pick the type of cord that will fill your requirements most efficiently and most economically.

To manufacturers who assemble their own cords, the superior design and consistent product quality of G-E cords can mean reduced set-up and adjustment time, more efficient production and a reduction of spoilage. To all manufacturers who use cord sets, G-E cords mean quality, efficiency, and economy.

If you would like detailed information on the possibilities of better on-the-job performance, or of more efficient production with G-E cords, write Section W184-667, Construction Materials Div., General Electric Company, Bridgeport 2, Conn.

Progress Is Our Most Important Product

GENERAL ELECTRIC

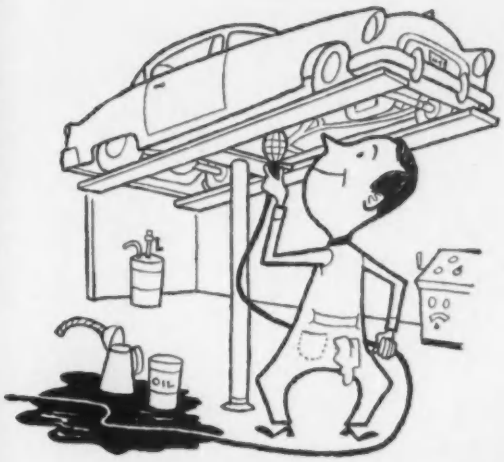
G-E cords for every product design

DELTABESTON* (Rated 300 V)—Felted-asbestos insulation. Resists heat and moisture. No drying or deterioration even under constant high temperatures.

TYPE S RUBBER JACKET (600 V)—Tough, durable, long-wearing. Resists acids, alkalies and water. For extra-hard usage in mines, railroads, garages, factories.

TYPE SJ RUBBER JACKET (300 V)—Properties similar to type S, but for hard usage on medium-duty applications (i.e. office machines, portable tools, household appliances)

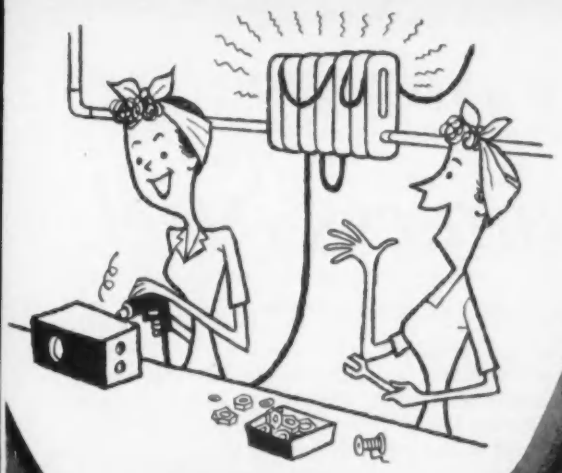
TYPE SV RUBBER JACKET (300 V)—Properties similar to type SJ, but for light duty.



SINK IT...

SNAG IT...

your products win the battle of abuse



HEAT IT...

BEAT IT...

TYPE SO GEOPRENE* (600 V)—Resists grease, oil and other rubber solvents, sunlight, flame, acids, alkalies and water. For industrial, garage, chemical and soap plants and similar locations.

TYPE SJO GEOPRENE (300 V)—For appliance, office machine, portable tool applications where resistance to grease, oil, sunlight, flame, acid, alkalies or water is required.

TYPE POSJ RUBBER RIP CORD (300 V)—For light-duty pendent or portable use in damp locations and for table and floor lamps, clocks, radios, etc.

TYPE POT FLAMENOL* RIP CORD (300 V)—Outstanding for its smooth, attractive finish. Will not deteriorate or change color. For light-duty use on table and floor lamps, radios, fans and other small devices.

PREENX* HEATER CORD—For high-heat applications (soldering irons, toasters, grills, heat lamps, etc.). Easy to rip and strip. Moisture resistant. Smooth finish does not attract lint—stays clean, resists staining and discoloration. Outwears fabric cord ten to one.

**Registered Trade-mark General Electric Company.*

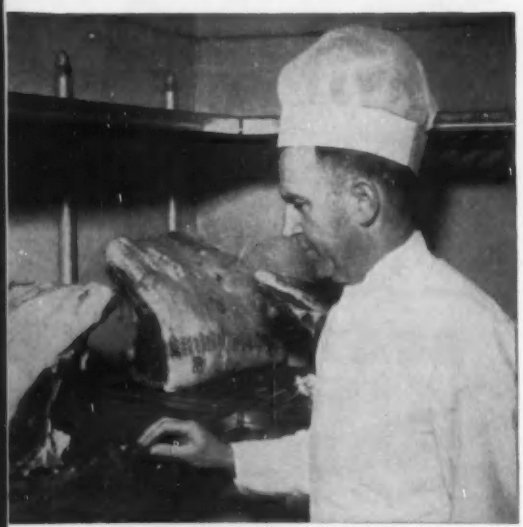
FOR COMPLEX FABRICATION. In chemical plants, these Stainless Steel acid catchers are used to remove dilute sulfuric acid from gases. Continental Boiler & Sheet Iron Works in St. Louis fabricated the units. Notice the complicated curves in the helix plates, and the neat joinery . . . a tribute to fine craftsmanship and the workability of Stainless Steel.

FOR ABRASION AND CORROSION RESISTANCE. Oil can racks stand out in all kinds of weather, and the support strips are constantly rubbed and knocked by the heavy cans of oil. Modern Metal Products Company of Greensboro, N. C. makes the strips out of Stainless Steel so they will stay bright and new-looking, and never get banged out of shape.

NOTHING *can equal* *Stainless Steel*

In its combination of desirable properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.



FOR SANITATION. These Stainless Steel shelves are made by the Eastern Steel Rack Company, Boston, Massachusetts, for use in cold storage rooms. They are easy to clean, and offer a sanitary, corrosion-resistant surface for food products of all kinds.

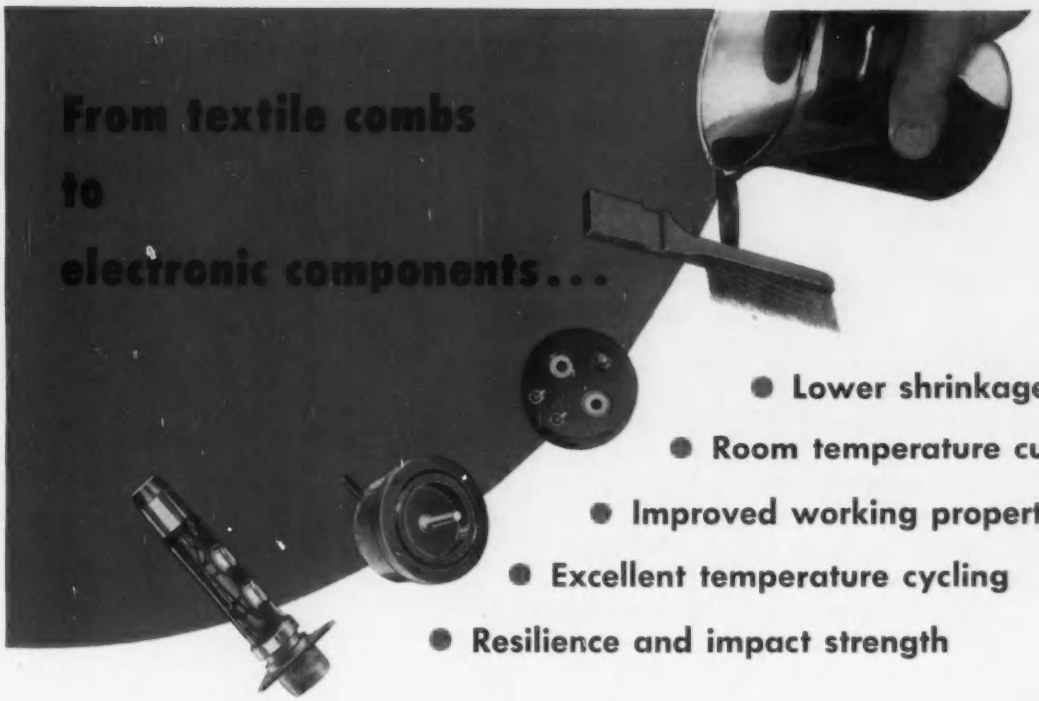
UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS
PIPE • TUBES • WIRE • SPECIAL SECTIONS

USS

UNITED STATES STEEL



- Lower shrinkage
- Room temperature cures
- Improved working properties
- Excellent temperature cycling
- Resilience and impact strength

VERSATILE ELASTOMERIC ALLOYS

of *Thiokol*® Liquid Polymers and Liquid Epoxies

FILL COUNTLESS PRODUCT NEEDS

Check the five key properties listed above and see where elastomeric alloys of "Thiokol" liquid polymer and liquid epoxies fit into *your* product plans.

These new elastomeric alloys have already proved their value in plastic tooling, encapsulating, casting and sealing. While retaining all the basic advantages of the epoxy resins (high strength, chemical resistance, good electrical characteristics and excellent adhesion), they also provide unequalled resilience and impact strength. What's more, a wide range of important new properties can easily be developed by simply varying the ratio of "Thiokol" liquid polymer to epoxy resin.

Shown above are some typical applications for elastomeric alloys. The fact that they are used for encapsulating electronic and electrical components . . . for durable potentiometer components . . . and even for imbedding teeth in textile combs is proof enough of their amazing versatility. They also meet the exacting requirements of the plastic tooling, sealing and adhesive fields.

For complete information on the properties and potentialities of elastomeric "Thiokol" liquid polymer/epoxy resin alloys, write: THIOKOL CHEMICAL CORPORATION, 784 NORTH CLINTON AVE., TRENTON 7, N.J. In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario.

Thiokol®

PIONEER MANUFACTURERS OF SYNTHETIC RUBBER

Design data on adhesives

NUMBER THREE

Armstrong
ADHESIVES • COATINGS • SEALERS

Strengthening a metal-to-metal joint

Four basic rules must be kept in mind in order to strengthen any joints to be adhesive-bonded.

These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

Here's how two of these rules were applied in improving the bond of a metal label to a fire extinguisher.

A

This label was designed for fastening with rivets. The label is flat, has embossed letters, and has holes drilled for riveting. Contact is very poor because of the embossing, resulting in low strength and low resistance to peel or cleavage stresses on the edge of the joint.

B

Remedy

This label was designed for adhesive bonding. The label is pre-curved and has a smooth back for 100% contact. This type of bond will prevent failure when a stress is applied at the edge of the bond with a fingernail or, for example, with some sharp instrument.

1. Bonded area has been made as large as possible.
2. Maximum proportion of bonded area now contributes to strength.

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8006 Irvin St., Lancaster, Penna.

Factors in adhesive bonding

Most assembly requirements for adhesive-bonded materials include factors of time, heat, and pressure. These vary with the adhesive used and also with the materials bonded.

Time

Two time factors are involved, open time and setting time. Open time is the period of time that can or must elapse between coating the parts and joining them. Some adhesives permit little open time; others must be kept open for intervals ranging from five minutes to twenty-four hours.

Setting time is the period that must elapse before an adhesive bond attains its full strength. Here again the interval may be measured in seconds or weeks, depending upon the adhesive, the materials bonded, and the curing procedure, if any.

Heat

Heat is required in varying degrees in many adhesive applications. Whether one or both surfaces are coated, forced drying of the adhesive film by heating and circulating air is usually desirable and often necessary. The use of heat speeds drying, makes drying independent of weather conditions, and prevents water condensation on the adhesive film.

PHOTO COURTESY CHEVROLET-DETROIT GEAR AND AXLE DIV., GENERAL MOTORS CORP.

ADHESIVE-COATED brake shoes and brake bands are assembled on a conveyor line. The brake band is first placed inside a pressure band and against the brake shoe. Pressure springs are then positioned. The assembly is then baked.

Controlled drying also makes it easier to begin assembly when the adhesive film has the right amount of tack, this being the point at which the best over-all bond can be made. Under some conditions, it may be more practical to dry the adhesive film completely and later reactivate it with heat or a solvent.

Special Factors

Thermosetting adhesives, which set by a chemical change in the presence of heat and/or a curing agent, require special assembly techniques. Adhesives of this type are most always used in critical applications where the possibility of bond failure cannot be tolerated—as in the bonding of clutch facings to steel plates. Since such bonds cannot be tested except by destruction, they must be made with extra care and control.

Curing

Some thermosetting adhesives must be cured by chemical reaction at room temperature, the bonded parts remaining clamped for a relatively long period of time. Oven heating of assemblies is quite common. Ovens may be heated by gas, oil, electric, or by infrared units. Forced circulation is required by oven heating in order to insure uniform temperature. The fastest curing time is accomplished by dielectric heat, which cures some heat-set adhesives in a few seconds.

Thermosetting adhesives may be cured at temperatures from 75° to 550° F., depending on the specific type. In general, the higher the temperature, the faster the cure. By controlling temperature, the bonding operation can be speeded or slowed to match the pace of almost any assembly line. Parts bonded with thermosetting adhesives usually can be taken from the presses while still hot.

For detailed information on bonding thermosetting adhesives, see the Armstrong Data Sheet, "Thermosetting Adhesives." It is available upon request. Write for your copy today.

New DynAC® stops motors *instantly*...without a ripple!

Here's dramatic proof of the smooth, controlled braking action of the new Westinghouse DYNAC braking controller. Motor stopped *instantly*—without disturbing the water in the glass goblet. "Grabbing" or jerky stops are eliminated with DYNAC braking.

Wherever rapid and/or controlled stopping is required, DYNAC can not only contribute an important safety factor, but it can save you headaches—*and money*—on: (1) production time, (2) material rejects and spoilage, and (3) maintenance expense.

Because it's *completely* electrical, DYNAC requires no mechanical apparatus or motor linkage—it simplifies maintenance. And it comes in *one* compact, spacesaving enclosure. Get the facts on DYNAC's many cost-cutting applications—with every type of standard induction motor. Use the coupon below for more information on DYNAC. J-30200

YOU CAN BE SURE...IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
P.O. Box 868, Pittsburgh 30, Pa.

Please send me descriptive bulletins 15-600 and B-6572 on the new DYNAC braking controller.

Name_____

Company_____

Address_____

City_____ State_____

need quick service on TIMERS for automatic control?

Time Delay Timers

The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

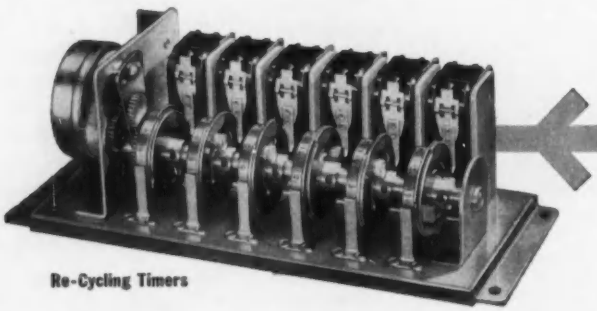
If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.

Interval Timers



Re-Cycling Timers

Running Time Meters

Timers that Control the Pulse Beat of Industry

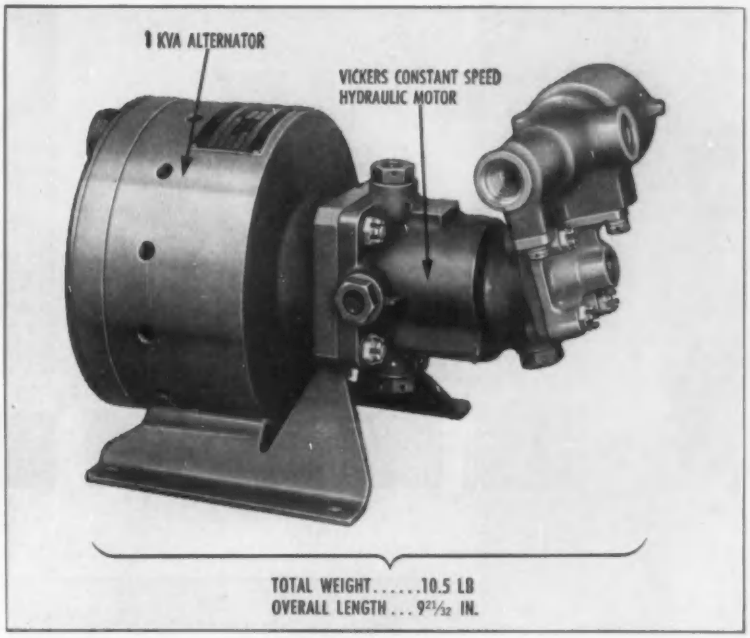
INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

New Vickers Airborne Electrical Power Package

. . . Saves Weight and Space

Utilizes the Hydraulic System for More Efficient Production of AC Power



This new isolated electrical power package provides closely regulated AC power with minimum weight and envelope while drawing its power from a hydraulic system. In new designs or when adding electronic equipment to aircraft designs in which the electrical system is already loaded to capacity, this versatile package provides the needed AC power from flow available in the hydraulic system. This generally is permissible without system change as the full flow is seldom demanded except for a few seconds under rare circumstances. Even in such cases, full flow can be guaranteed to these hydraulic functions through the use of a simple priority valve which starves the AC power package momentarily.

Less Weight and More Efficient

Important weight savings are achieved through the use of this package instead of an inverter which may also require an increase in the AC generator and line capacities. In one instance, the 10.5 lb 1 kva package replaced a 38 lb inverter for co-pilot instrumentation. An additional advantage is that the package has 62% overall efficiency while that of the inverter was 35-40%.

Extreme altitude operation is no problem as the Vickers isolated electrical power package contains no brushes or other altitude-sensitive components.

Features of AC Generator

The permanent magnet type AC generator has excellent life and reliability. It requires no bulky voltage regulator . . . is inherently smaller and lighter than conventional generators due to the elimination of the exciter and slip rings. It also has higher overall efficiency resulting from elimination of all excitation losses. Additional advantages are that the permanent magnet is unaffected by momentary short circuit, or separation of field and armature without keeper, or by temperature cycling. It is also not susceptible to aging or shock. This unit is 120/208 volt, three phase, wye connected with 400 cps at 8000 rpm. It is capable of continuous duty under environments of 0-55,000 feet altitude and ambient temperatures from −65 F to 250 F.

Hydraulic Motor Drive

The generator is directly driven by a Vickers Constant Speed Hydraulic Motor having fixed stroke and an integral flow control valve that maintains an 8000 rpm speed setting within ±2½% regardless of the load (as long as valve inlet pressure is greater than load requirement). For the unit shown above, maximum operating pressure is 3000 psi while rated output of 1 kva requires operating pressure of 2200 psi. Special configurations will maintain 400 cps frequency within ±0.1% regardless of load. This motor has a very high horsepower-weight ratio and its overall efficiency exceeds 92%. It is a time-proved design capable of many hundreds of hours of continuous service without attention.

Many Uses and Sizes

The applications for this isolated power source are numerous. For multi-engine aircraft, its use for co-pilot instruments provides dual reliability. This package has been used to supply controlled frequency AC power in emergencies when the only source of power in the airplane is a ram air turbine driven pump. The efficiency of this arrangement minimizes the size and weight of the ram air turbine necessary to provide emergency hydraulic and electric power.

Now available in the sizes listed below, larger packages can also be supplied from existing components. Vickers is prepared to develop the package best suited to a specific need. For further information, get in touch with your nearest Vickers Aircraft Application Engineer.

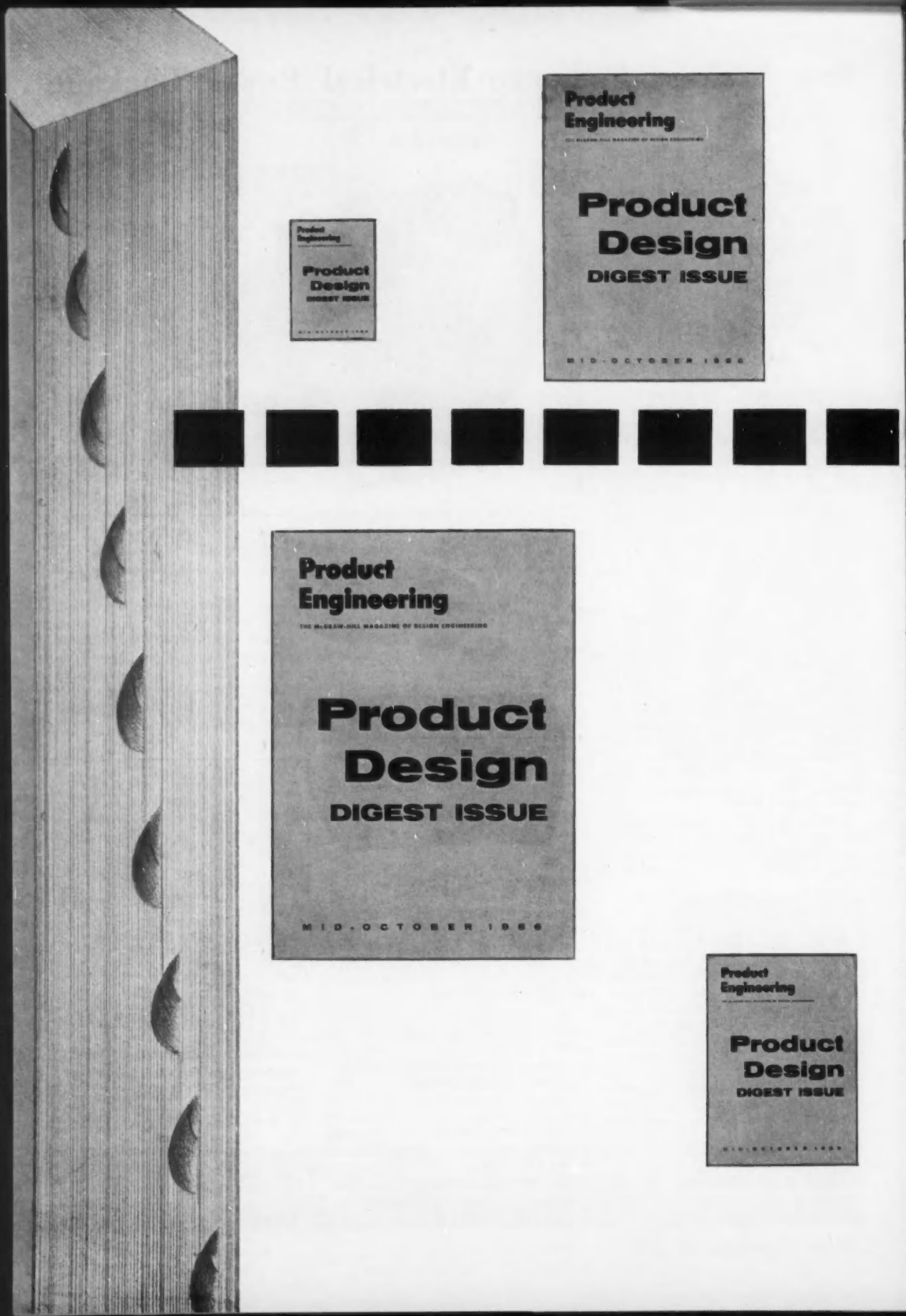
Vickers Airborne Electrical Power Packages

kva output	weight, pounds
0.5	7.0
1.0	10.5
1.5	12.5
2.0	15
2.5	17
3.0	19

Larger capacities with minimum weight are available.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1454 • Detroit 32, Michigan
Aircraft Application Engineering and Service Offices: El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) • Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7 Wyatt Bldg. Additional Service facilities at: Miami Springs, Florida, 641 De Soto Drive
TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149
CABLE: Videt
OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England

Engineers and Builders of Oil Hydraulic Equipment Since 1921


Product Engineering
Product Design
DIGEST ISSUE
MID-OCTOBER 1956
Product Engineering
Product Design
DIGEST ISSUE
Product Engineering
Product Design
DIGEST ISSUE
MID-OCTOBER 1956
Product Engineering
Product Design
DIGEST ISSUE

THUMB YOUR WAY TO BETTER PRODUCTS

The product-design engineer most valued by his management . . . can find solutions to problems when they are most needed and wanted . . . can bring the benefits of new ideas and proven engineering principles to his company's products. Product Engineering's PRODUCT DESIGN DIGEST ISSUE helps you to be such an engineer. Thumb-indexed for quick reference, it puts at your fingertips hundreds of the most significant developments in the field of design engineering . . . facts and valuable data not readily available anywhere else. Over 21,000 technical articles will be screened by our separate, full-time, year-around editorial staff to make sure that the 1956 DIGEST ISSUE is the most helpful one yet. And, of course, you will get this valuable reference issue in mid-October as part of your subscription to *Product Engineering*.

Product Engineering

ABP ABC

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

McGRAW-HILL BUILDING, NEW YORK 36, N.Y.

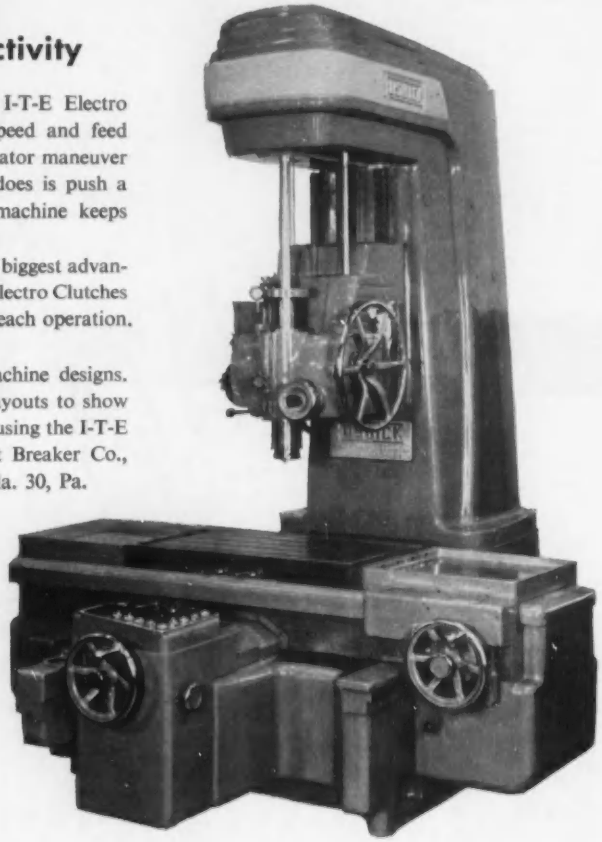
I-T-E ELECTRO CLUTCHES MAKE POSSIBLE SPEED AND FEED CHANGES IN 1/2 SECOND

Easier operation boosts productivity

The Fosdick Machine Tool Co. has now incorporated I-T-E Electro Clutches into its precision jig borers. Formerly every speed and feed change meant the machine had to be stopped and the operator maneuver a mechanical slide-gear shifting mechanism. Now all he does is push a button on the conveniently located control panel. The machine keeps running; keeps producing.

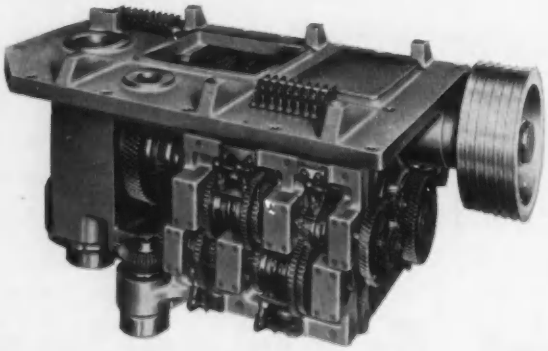
Easier operation and increased production—these are the biggest advantages that I-T-E Electro Clutches can add to machine tools. Electro Clutches make it easier to operate machines at their best speeds for each operation. In addition, they have transmission gear space.

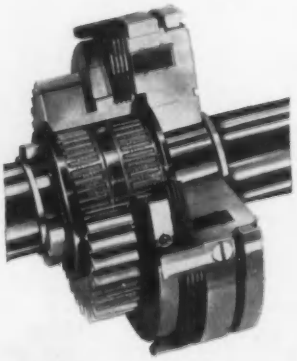
I-T-E Electro Clutches are available to fit existing machine designs. I-T-E application engineers will be glad to help prepare layouts to show you the space-saving possibilities and ease of control when using the I-T-E Electro Clutches. Write for Bulletin #5306. I-T-E Circuit Breaker Co., Transformer-Rectifier Division, 19th & Hamilton Sts., Phila. 30, Pa.



FOSDICK PRECISION JIG BORER MODEL H-1015

SPACE SAVER. Complete transmission for the Fosdick machine. Notice compactness and simplicity for mounting I-T-E Electro Clutches on same shafts with gears. Clutches operate right in housing with oil lubricant.



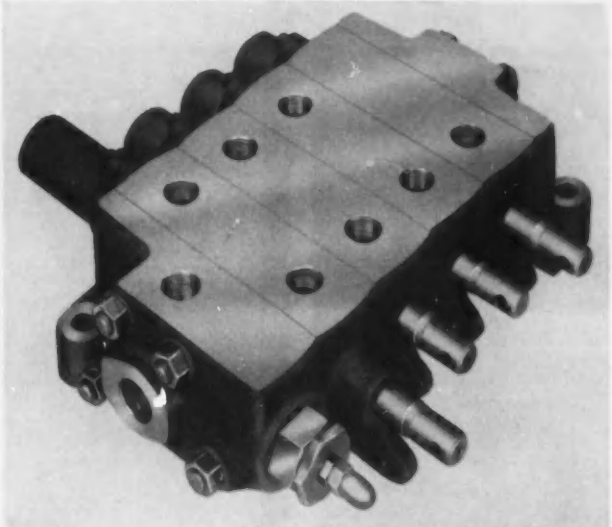


NO ADJUSTMENTS. The I-T-E Electro Clutch is simple, compact, requires no adjustments for wear. Available in torque ratings from 3.2 ft. lb. to 45,000 ft. lb.

I-T-E

I-T-E CIRCUIT BREAKER COMPANY • Transformer-Rectifier Division

ALL NEW PERFORMANCE RATED VALVES



multiple directional control valve

. . . prevent load-drop

. . . have low pressure loss

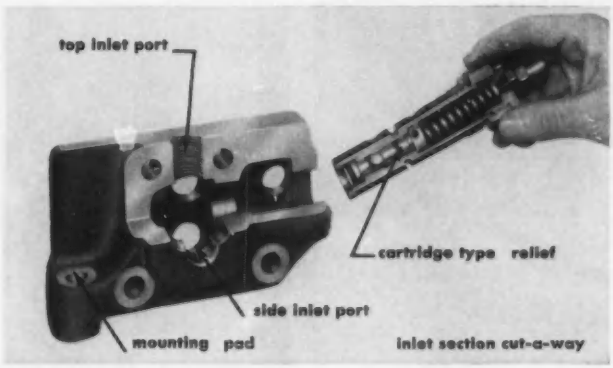
HERE IS A NEW directional control valve having greatly improved operating characteristics. Now you can get higher performance from oil hydraulic cylinders and motors because the pressure loss inside these valves is less, therefore, more fluid power is available to perform work.

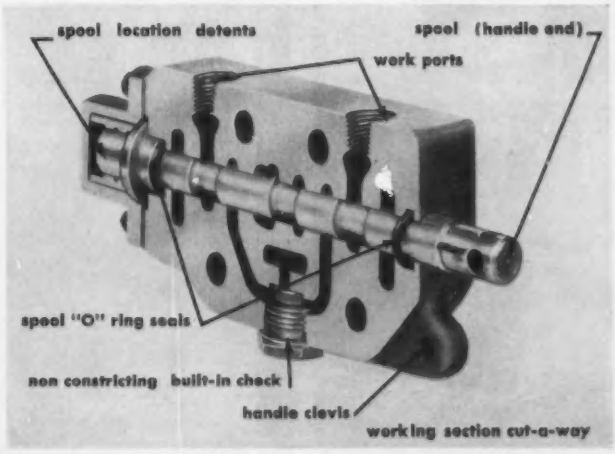
The rating of these valves is based on their performance under operating conditions and not by the size of their work ports. You can now determine the valve pressure loss and know the total power required to do the job. It is easy to pick the correct size of the valve to control this power with a pressure loss low enough to not cause excessive heat.

Constructed with solid, balanced spools, the valve working sections each have a built-in check; so that no pressurized return flow and, therefore, no load drop, can occur even if two or more sections are in operating positions at the same time. Check valves are located so that they cause no constriction of oil flow passages.

Side and top inlet and outlet ports are provided, and direct return tank mounting is available. Valves can be furnished with ports designed for tapered thread or SAE split-flange connections. Working sections having three-way, three position; four-way, three position and four-way, four position actions are available and can be assembled in any combination or sequence.

Other features include greatly reduced resistance to flow through internal passages, sealing by O-rings instead of gaskets and a unique cartridge type pressure relief valve. . . . For complete data, write to Dept. G-22, The Commercial Shearing and Stamping Company, Youngstown, Ohio.





COMMERCIAL SHEARING AND STAMPING

Have you evaluated your

TRIANGLE MFG. CO.
"cut costs 15%"

GAST MANUFACTURING CORP.
"30% lighter, but performs better"

ROWE SPACARB, INC.
"saved $3 per unit"

AMERICAN-STANDARD
"cut product size and weight"

PACIFIC PUMPING CO.
"helped double sales"

DECORA MFG. CO.
"saved 40¢ per unit on shipping"

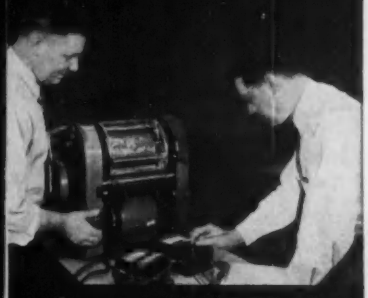
SWEDEN FREEZER MFG. CO.
"most dependable motor"

AIRCRAFT-MARINE PRODUCTS, INC.
"extremely low service expense"

DEMING COMPANY
"saved on handling and shipping"

motor savings yet?

AMERICAN BLOWER CO.
"reduced motor stocks"



A. B. DICK CO.
much more value for your money"

UNIVERSAL INDUSTRIES
"helped make peeler portable"

FINNELL SYSTEM, INC.
"100% standardized on G.E."

TODAY THOUSANDS OF COMPANIES CUT COSTS, BOOST QUALITY WITH ADVANCED G-E MOTORS

In the past four years, equipment manufacturers have bought nearly 5,000,000 smaller, lighter G-E fractional-hp motors. Today, they testify to the *tangible, measurable benefits* they have realized. For example:

MANUFACTURING AND SHIPPING SAVINGS amounting to about 15% resulted from a Detroit pump manufacturer's* decision to switch to advanced-design G-E motors. Rugged construction of the G-E motor permitted direct mounting, eliminated several parts. Lighter weight reduced worker fatigue, helped speed assembly—shipping and packaging savings alone were 30¢ per unit! Result: a better-looking, more efficient unit which sells at a 10% lower price!

GREATER POWER AT NO EXTRA COST helped a Chicago office machine manufacturer* boost the saleability of his product. Lower handling, shipping, and assembly costs, modern appearance, and the sales value of the G-E monogram cause this well-known manufacturer to credit the G-E motor with making it "easier to design, build, ship, and sell" his machines.

UNSURPASSED DEPENDABILITY of the "years-ahead" G-E motor is a proven fact to thousands of manufacturers. A typical experience is that of a California compressor manufacturer*, who introduced a G-E powered paint sprayer over two years ago. To date 99.9% of these units have never required motor service.

TREMENDOUS SALES APPEAL of products designed to take advantage of all the G-E motor benefits is typified by the case of a West Coast pump manufacturer*. Just one year after introducing a streamlined new unit, made smaller and easier to handle by the G-E motor, his manufacturing costs had been reduced and his ***sales had doubled!***

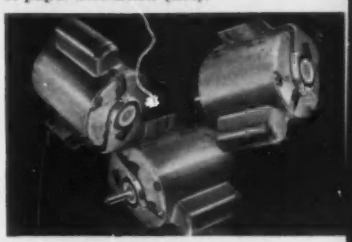
"Years-ahead" design and proved performance of the G-E motor are helping to establish the leaders in many fields. If you'd like more information, or help in taking greater advantage of the G-E motor's benefits in your products, contact your nearby G-E Apparatus Sales Office, or write to Section 702-24, General Electric Co., Schenectady 5, New York.

**Actual case histories available on request.*
†Dupont trade-mark for polyester film

ONLY G.E. OFFERS ALL THESE FEATURES

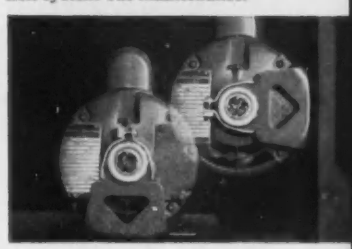
MORE COMPACT—up to 40% smaller, 50% lighter—saves you material and handling costs.

MYLAR† INSULATION (right)—35 times the moisture resistance of paper insulation (left).



ALL-ANGLE OPERATION—protective lubrication in any position—without costly specials.

DOUBLE LUBRICATION LIFE—50% more oil, efficient retention system cut maintenance.

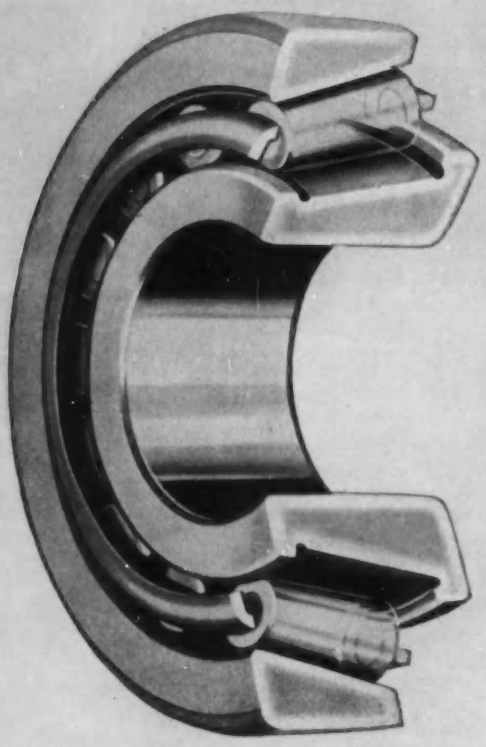


MOUNTING VERSATILITY—rotate motor in resilient *or solid base.* Cradle easily removed.

Progress Is Our Most Important Product

GENERAL ELECTRIC

There's a BOWER TAPERED ROLLER BEARING engineered to fit your product



Types and sizes to fit a wide range of tapered bearing applications

There's no need to compromise with bearings! Whatever your product, if it uses tapered roller bearings, call in a Bower engineer for expert help on selecting the exact type and size you need.

Depending on your own particular needs, he'll make sure you get the exact size and type—selected from Bower's complete tapered line—engineered to assure maximum performance in your application.

Most important of all, when you specify Bower tapered roller bearings for your product, you get all the advantages of advanced Spher-O-Honed design—less maintenance, longer life, smoother operation. Get the full facts on the complete Bower line.

Tapered, Straight and Journal Roller Bearings for every field of transportation and industry

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.

use Porcelain Enamel

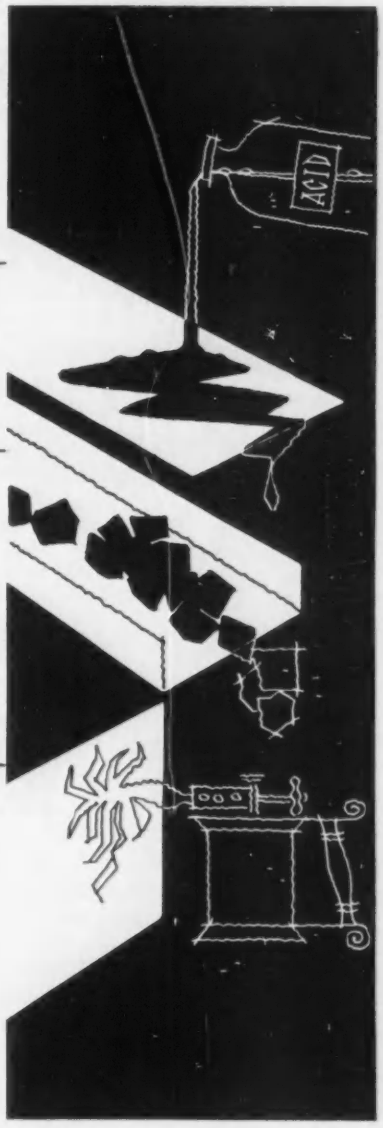
to protect your products

against:

corrosion

abrasion

high temperatures



No other finish can give the protection afforded by Porcelain Enamel! This completely inorganic material, combining the strength of steel with flint-hard glass, is unaffected by conditions that would wear-out, rust-out or burn-up other materials. By using Porcelain Enamel in critical applications, designers improve the performance of their products, and at the same time frequently reduce weights and lower costs.

And where beauty and color are desired to increase the attractive appearance and sales appeal of a product, Porcelain Enamel fills every requirement. It is unsurpassed in range of colors and surfaces, and retains its original beauty and color *for life*!

We will be glad to help you use this modern material to make *your* products more serviceable, more durable, more salable.

PORCELAIN ENAMEL

PORCELAIN ENAMEL INSTITUTE, INC.

This message sponsored by the Frit Division of the

PORCELAIN ENAMEL INSTITUTE, INC.

1145 Nineteenth Street, N. W. • Washington 6, D. C.

PORCELAIN ENAMEL INSTITUTE, INC.
1145 Nineteenth Street, N. W., Washington 6, D. C.

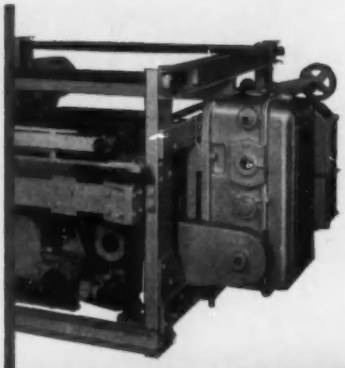
Please send me design information about PORCELAIN ENAMEL for possible application to_____
(type of product)

Name_____

Company_____

Address_____

Size 112, 8:1 Speed Range, Lewellen V/S Transmission driving capstan— one of 50 installations, totalling 700 years' service, at Johnson Steel and Wire Co., Worcester, Mass.



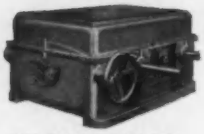
Size 110, 5:1 Speed Range, Lewellen V/S Transmission, driving wire-cut section of 600 foot line of Green bakery equipment, producing 5000 pounds of cookies or crackers per hour.

Get Selective Operating Speeds with a LEWELLEN VARIABLE SPEED TRANSMISSION

VERTICAL OPEN V/S TRANSMISSION

VERTICAL ENCLOSED V/S TRANSMISSION

HORIZONTAL OPEN V/S TRANSMISSION



HORIZONTAL ENCLOSED V/S TRANSMISSION

Selective operating speed is frequently the most direct and effective control of a product.

With the Lewellen V/S Transmission, speeds are finely selective, INFINITELY adjustable.

All speeds are immediately available, conveniently obtained, and precisely regulated.

A choice of four standard units—
with accessories and controls
in speed ranges to 20:1
in rating to 60 horsepower
adapts the Lewellen to any equipment.

ACCURATE REGULATION

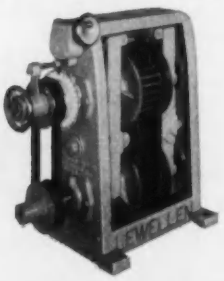
Inherently accurate speed regulation is characteristic of the Lewellen V/S Transmission.

With uniform load, speed ratios are accurately maintained with negligible drift.

Incremental speed adjustments, in fractional r.p.m.'s, are available and stable.

The Lewellen is sensitive and responsive to critical control—manual or automatic.

For precise speed ratios, a differential device is available, which may be zeroed to indicate any transient drift, and may be timed to measure fine rate adjustments.



WRITE FOR CATALOG NO. 65

LEWELLEN MANUFACTURING CO., COLUMBUS, IND.

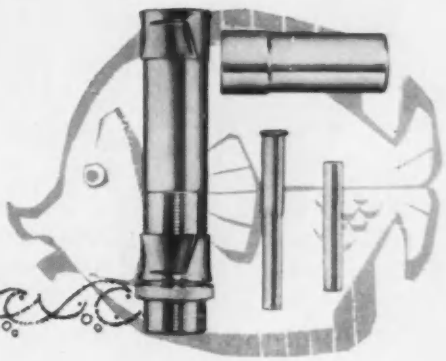
DISTRIBUTORS IN ALL INDUSTRIAL AREAS • IN CANADA—PEERLESS ENGINEERING SALES LTD., TORONTO—MONTREAL

Short Cuts to Finished Products . . . *by Anaconda*

Aluminum Ferrules For Fishermen—

Allan Manufacturing Company, Hicksville, N. Y.

As the world's largest producer of fishing tackle hardware, the Allan Mfg. Company serves more than 25,000,000 fishermen. For brass and aluminum, the materials used in large quantity items like the ferrules shown, they turn to The American Brass Company. The reel seat and rod ferrules shown are aluminum, which is later anodized and colored. Allan Manufacturing Company also makes all-brass tackle hardware, using many other Anaconda products.



Red Brass Water Supply Nozzle For Thirsty Hens—

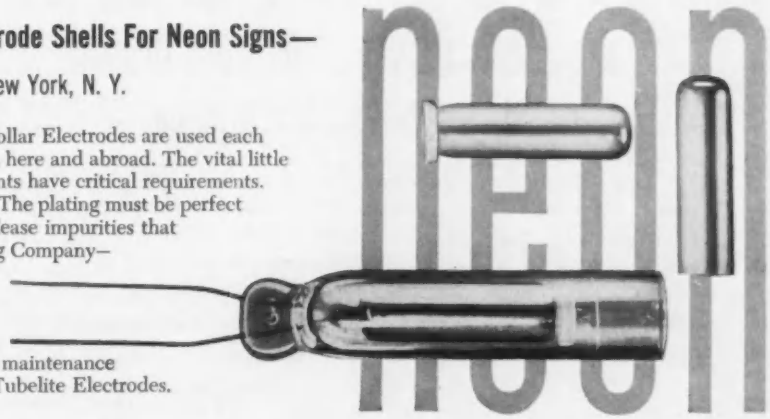
Fox Products Company, Philadelphia, Pa.

The Constant Level Water Valve, made by Fox Products, automatically keeps fresh water available in poultry house troughs to help stimulate maximum growth and egg production. It also protects the health of chickens by shutting off water supply when hens accidentally tip the water trough over. Fox first tried a plastic nozzle on the valve—found it unsatisfactory. Red Brass was a natural for resisting corrosion of the air-water mixture in the nozzle. Instead of tooling up for this part, however, Fox Products found it more economical to have the nozzle made by The American Brass Company.

Nickel-Plated Armco Iron Electrode Shells For Neon Signs—

Tube Light Engineering Company, New York, N. Y.

Millions of these Tubelite Ceramic Collar Electrodes are used each year to keep neon signs glowing, both here and abroad. The vital little nickel-plated iron electrode components have critical requirements. Close tolerances must be maintained. The plating must be perfect —porosity and uneven plating can release impurities that darken tubes. Tube Light Engineering Company—leading manufacturer and distributor of neon tube supplies—turned to the specialized facilities offered by The American Brass Company for both forming and plating, to simplify maintenance of quality standards set up for their Tubelite Electrodes.



The American Brass Company has specialized equipment, such as high-speed multiple-plunger presses, for the economical production of parts like these for industry. It has the experience and skill to design tools which reduce the number of operations and lower production costs—techniques developed over a century of service to manufacturers.

YOUR CHOICE OF METAL: Parts like these can be furnished in copper, brass, bronze, nickel silver, nickel, iron, stainless steel, steel, and aluminum—in a wide variety of finishes.

FOR AN ESTIMATE: Just send a sample, drawing, or description, together with quantity and other pertinent information. Address: The American Brass Company, Waterbury Brass Goods Division, Waterbury 20, Conn.

ANACONDA®

MULTIPLE-PLUNGER PRESS PRODUCTS

NEW!

..LaSalle introduces another quality product!

LARGE HEXAGONS

available NOW! . . in cold-drawn steel bars (GRADE C 1018) . . sizes to 4"

Yes, you can now buy cold-drawn hexagon steel bars in sizes up to and including 4". Effective immediately, LaSalle offers 3¼", 3½", 3¾" and 4" diameter hexagons . . in addition to conventional sizes ranging from ⅛" to 3".

No longer is it necessary to resort to costly and time-consuming forging, milling or other machining to produce large-size hexagons.

And with *cold-drawn* large hexagons you naturally get the superior mechanical qualities inherent in cold-drawn steel bars. Ask your steel distributor for Large Hexagons by LaSalle.

La Salle STEEL CO.

the Most Complete Line of Carbon and Alloy Cold-Finished and Ground and Polished Steel Bars in America.

For additional detailed information, send for your copy of this helpful new data sheet, "Large Hexagons."

LA SALLE STEEL COMPANY
1430 150th Street
Hammond, Indiana

Please send me Helpful Data Bulletin No. 14 "Large Hexagons"

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Perspectives

IN DESIGN AND DEVELOPMENT

DEFENSE ESSENTIALITY: A NEW INVESTIGATION

The "watch tariff case", a term synonymous with the new phase "defense essentiality", is back before the public eye again. Recently the Office of Defense Mobilization (ODM) announced that it will conduct another investigation on the effect of watch imports on the domestic watch industry (Hamilton, Elgin, Bulova, and Waltham). In July 1954 the tariff on imported Swiss watches was increased by 50 per cent to protect the domestic watch industry, because it was regarded as essential to national defense. Now, almost two years later, the patient is returning to the doctor for re-examination, and the ODM wants to know what the effect of the tariff increase has been. But in addition, the ODM is asking (1) the department of Defense and Commerce what the wartime requirements of the jeweled watch industry would be; and just what products would be made by this industry in an all-out war; (2) the Labor Department to find out what the problems are relating to labor skills; and (3) what is the level and trend of domestic watch production. A fourth probably will be a parallel investigation of the "defense essentiality" clause in Section 7 of the Trade Agreements Extension Act of 1955. Already, as a result of the jewel watch case, a number of industries have appealed to the ODM for tariff protection under the essentiality clause.

WATCH MAKERS WANT MORE PROTECTION

In spite of what the ODC plans to do with this new survey, the domestic watch manufacturers already have their story set: The 1954 tariff increase was not enough; all that it succeeded in doing was to level off our declining production curve. The figures for 1955 show that imports of Swiss jeweled watch movements decreased by 2¾ million, while the domestic watch manufacturers increased their production by only 200,000 during the same period. There is another equally strange situation. In the ODM report of 1954, which led to the tariff increase, Department of Commerce Secretary Sinclair Weeks maintained that a domestic production of a minimum of 3-million jeweled watches per year would be necessary to meet the essential non-military requirements under full mobilization. Just last month the same Commerce Department published a list of formerly "strategic" goods that now may be exported. On that list was: "one-day alarm clocks, watches, and watch movements."

SIDE BUSINESSES ARE PROFITABLE

As has been stated before, the domestic watch companies are not exactly going broke. In 1952, total sales were $131-million; in 1953, $159-million; and in 1954, $167.5-million. Admittedly, the greater percentage of this income is not from watch sales. All of the watch companies have diversified, mostly in the electronics field, and most of the business has been with government defense contracts. Yet, these earnings are not being pumped back into their watch business.

(Continued on page 131)

phenolic parts by Chicago Molded

An exclusive feature of Rheem's "Wedgewood" Clothes Dryer is its special delicate-fabrics compartment. Here, gentle-action drying is achieved without tumbling and without high heat – by using massive volumes of warm air.

To get this large volume of air calls for a large impeller, and three baffles which insure activation of the clothes. The impeller is designed to operate at up to 1750 rpm.

Chicago's Molded's materials laboratory worked closely with Rheem engineers to determine the materials that would best meet these specifications.

For the impeller, they came up with a cotton-filled phenolic material that's strong enough to take the whirling beating of high speed, yet is resistant both to moisture and to household detergents. The steel shaft of the impeller is inserted during molding – incidentally, positioning of this shaft demands extreme accuracy.

The baffles are made of a bright-red, flock-filled, medium impact phenolic – which also is both moisture- and chemical-resistant.

Your problems will receive the same exacting attention when you work with Chicago Molded. For it is analysis *at the blueprint stage* that prevents glaring mistakes from showing up later in your plastic components. That's why CMPC's experience *keeps* customers . . . over 60% have been working with us at least 15 years.

If you are interested in receiving periodic digests of new plastic applications and developments, send us your name and address. You will receive a complimentary subscription to Plastics Progress.

CHICAGO MOLDED PRODUCTS CORP.

2726 N. Kolmar Ave., Chicago 51, Illinois

Perspectives

NO SPECIAL WATCHES MADE IN U. S.

The Swiss cite as an example of the failure of the American watch industry to keep pace with the trend of the watch market, which has been towards self-winding movements, calendar watches, alarm watches, stop watches, chronographs, and other types. One U. S. firm manufactures men's self-winding movements; no U. S. firm manufactures a ladies' self-winding movement, calendar watches, alarm watches, or some of the other types developed by the Swiss. "Therefore," the Swiss claim, "since one-fifth of all the jewel-lever watch imports are of movements containing these special features not available in this country, these figures should not be included when a comparison of the "share of the market" is made. The result gives the U. S. watch manufacturers a better share than they claim."

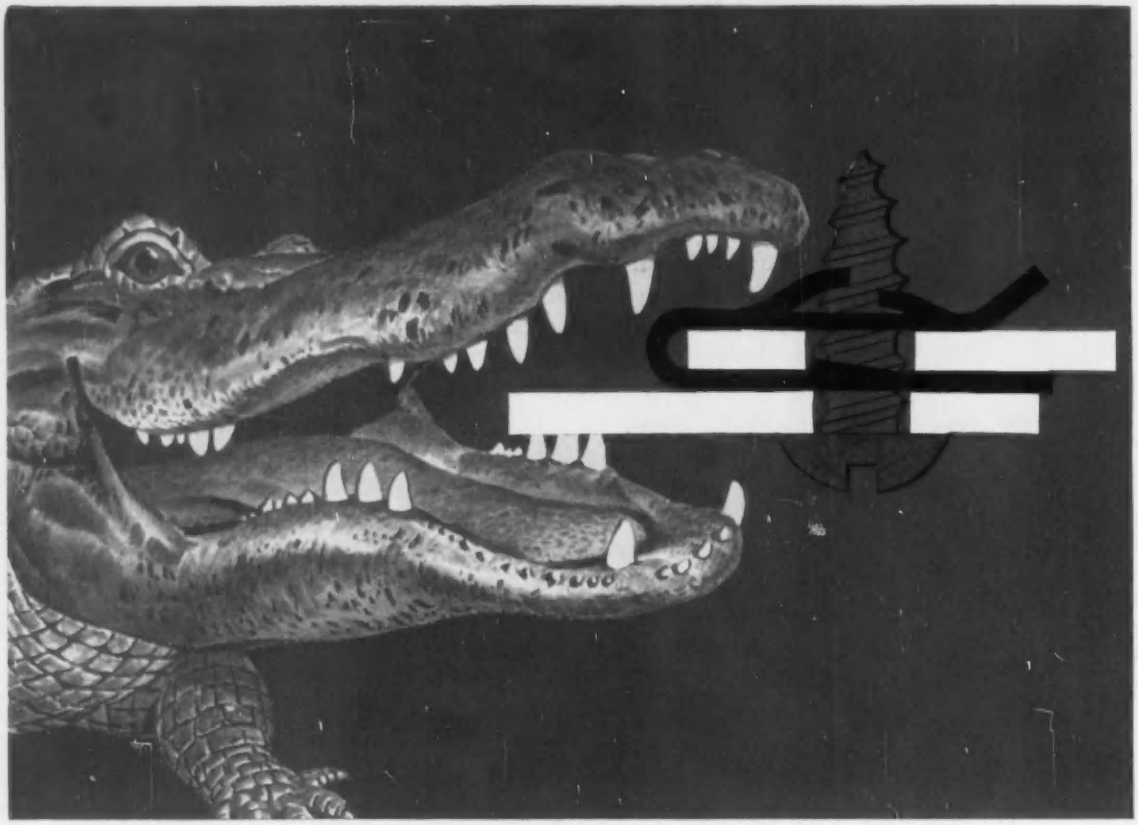
It is well known that the Swiss have many colleges for the high level training of their watch engineers. The U. S. has none. The ODM recognized this in their 1954 investigation of the industry and suggested that similar institutes be set up in this country. In a recent talk on the electronics industry, Mr. H. Leslie Hoffman, President of Hoffman Electronics, Los Angeles, Cal., made a remark that might well be applied to the watch industry: "The yardstick by which the component is evaluated is the same as the yardstick used to measure the value of the end equipment. If the degree of engineering content contained in the product is superior, the market will follow."

INDUSTRIALISTS STATE THEIR CASE

Several months ago Arthur Flemming, Director of ODC called a meeting of a number of Assistant and Under Secretaries of Treasury, Commerce, Labor, and other officials of the ODM. There to elaborate on the subject, "A New Look at Preserving Skills," were several top figures from industry: John S. Coleman, Pres., Burroughs Corp.; Thomas Reid, Vice-Pres., Ford Motor Co. and formerly Deputy Director of ODM for Manpower; C. H. Percy, Pres., Bell & Howell Co., and Harold Vance, Commissioner, Atomic Energy Commission, formerly Chairman of the Board of Studebaker-Packard.

Mr. Coleman said that it was incorrect to assume that it was necessary to maintain a labor pool of skilled production workers. What is important is a labor pool at the level of tool makers and design engineers. He felt that competent scientists, engineers, and tool makers can design and produce any tools, and can switch their activities from one industry to another; including those with very close tolerance work. Specifically, he stated that with very little difficulty a top-grade tool maker from his plant could make the most delicate equipment used in the watch industry. He thought that to strengthen and protect the U. S. mobilization base, the policy should be directed away from the protection of production workers (the policy of the domestic watch manufacturers), and redirected toward methods of maintaining a strong design engineering, and toolmakers pool.

Mr. Reid said that is was essential that critical skills be preserved, but felt that tariff protection was not the way to do it. Furthermore, he said that industry is becoming less and less dependent upon "hand skill."



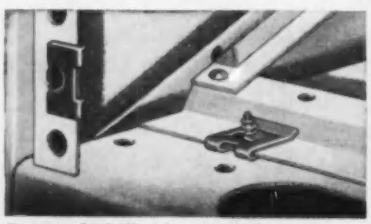
STEEL JAWS THAT NEVER RELAX
fasten a fastener in place

Alligator jaws have nothing on Tinnerman "U" and "J" type fasteners in gripping power. These fasteners press easily into locked-on position over panel edge or center panel locations. Yet they provide positive self-retention, ending the need for welding, staking or other secondary fastening devices. They are ideally suited for blind assembly or hard-to-reach locations.

When combined with the familiar Tinnerman SPEED NUT, this unique fastening principle provides a one-piece, self-locking, self-retaining fastener that is fast and easy to apply. The "U" or "J" feature can be combined with wire and tube retainers, latches, catches and a host of other fastening requirements to save time, material and production costs.

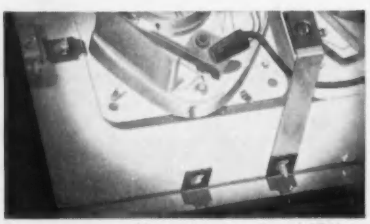
Find out about these and more than 8,000 other types of SPEED NUT brand fasteners now serving industry all around the world. They can make important savings for you, can also simplify your assemblies. See your Tinnerman representative soon or write to us. **Tinnerman Products, Inc., Box 6688, Dept. 12, Cleveland 1, Ohio.**

TINNERMAN
Speed Nuts®
FASTEST THING IN FASTENINGS®



Greater flexibility for control equipment enclosures is provided by self-retaining "J" type SPEED NUTS at 30% less production cost.

Assembly costs on this sheet-metal skylight frame are reduced 66% by Tinnerman "U" type SPEED NUTS.



Gas range assembly costs are reduced 25% to 50% by using Tinnerman "U" and "J" type SPEED NUTS.

Solving the Shortage Problem

MANY COMPANIES are concerned about the shortage of engineers. In our March number editorial we urged greater support of engineering schools by industry and a greater public demand for better high schools by industry and a greater public demand for better high school preparation for engineering colleges. These are essential steps in solving the problem. The results would not become evident for another decade. In the meantime the situation calls for action that will have immediate results. What more should industry do or not do to alleviate the shortage of engineers?

On the "should not do" side of the picture, it is reported that one company is now making bargains with college juniors. The student is offered part payment of his senior year expenses if he signs up to take a job with the company upon graduation. And then there are companies who gobble up all the engineering graduates they can, whether they need them or not. Both these practices are wrong.

Unsound and unfair practices in the hiring of engineers is bad for the profession, the company and the individuals involved. College professors can do much toward rectifying this situation by giving sound advice to the graduating engineers.

Another unsound business practice is the offering of excessively high starting salaries to the graduating engineers. This has a demoralizing effect on the college professors and instructors; it establishes false levels of salaries that are out of line with the salaries paid to the long time employees. The graduate thus hired soon begins to suspect that his employer will find some way of minimizing salary increases in order to bring his pay in line with that of the other engineers.

As opposed to the unsound practices, there are a number of obvious things that any company can do toward alleviating the shortage of engineers. By using engineers for engineering work only, by giving the engineers proper working space, by giving the engineers sufficient clerical help so that they can work more efficiently and get more work done, a company might find out that it doesn't need quite so many engineers.

Perhaps the worst evil is that of using engineers for nonengineering work. There is no need to hire graduate engineers as laboratory technicians. Properly trained, the high school graduate could do much of the time consuming estimating work in the average engineering department. A properly trained draftsman can readily become a layout man and do many of the design calculations.

Many of the larger companies have well organized training schools. Smaller companies may not be able to afford such schools. But the small company can pay a draftsman's tuition for night school courses. And there is nothing to prevent small companies from banding together to organize training classes to be taught in high schools of special institutions. Indeed, by a concerted effort, the smaller companies in a town might well prevail upon the school board to offer training courses for engineers in the local high schools.

Big or little, every company can help solve the engineers' shortage problem.

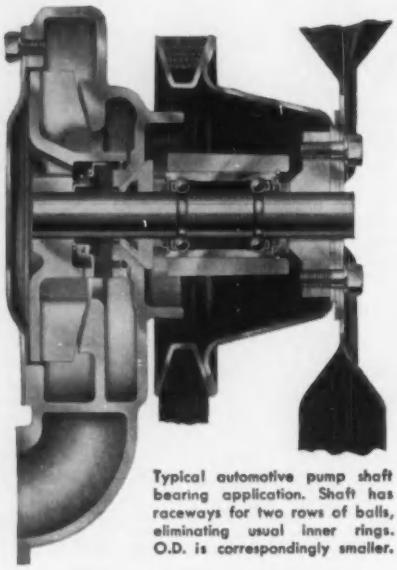
George F. Rodenhoff

FACTS

about

NEW DEPARTURE

BALL BEARINGS



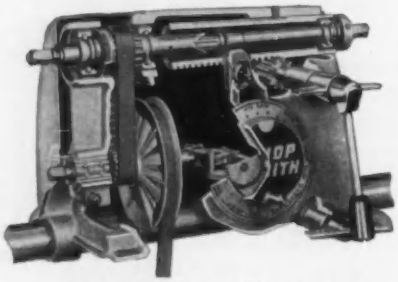
Typical automotive pump shaft bearing application. Shaft has raceways for two rows of balls, eliminating usual inner rings. O.D. is correspondingly smaller.

FAN AND PUMP SHAFT BEARING IS ADAPTABLE TO MANY USES!

This sealed and "lubricated-for-life" bearing with integral shaft was originated by New Departure specifically to simplify automotive fan and water pump mounting. Since its inception, it has reduced bearing maintenance requirements to virtually zero in millions of car, truck and other engines.

Because of its unique design and ability to locate parts on its shaft against loads from any direction, designers find it a highly *versatile* bearing, adaptable to many other uses.

The manufacturer of a well-known power tool, which combines several tools in one compact unit, employs the pump shaft bearing as a complete intermediate shaft with pulleys on one end and a keyway for tool attachment on the other, with obvious design and performance advantages.



Integral shaft of bearing serves as intermediate shaft in Magna's "Shopsmith". Assures fewer parts, easier machining, more accurate, quicker assembly.

Another manufacturer produces a power mower in which two of these versatile NEW Departures with hollow shafts not only support the mower rotors, but permit vertical adjustment of the wheel spindles to regulate cutting height.

So here is another NEW Departure adaptable to many uses. New Departure engineers can show you what it and other ball bearings will do to improve your products.

FINE BALL BEARINGS MAKE GOOD MACHINES BETTER

For each McCulloch Mower, New Departure provides two pump shaft bearings with hollow shafts to permit vertical adjustments. Special heat treating gives full hardness at the raceways but adequate toughness in the shaft to withstand hard service.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Analysis of Oscillatory Motion Using High Speed Photography

Derivation of expected timing and measuring accuracy, required film speed, and illustrative studies of a vibrating spring and motion of a solenoid armature.

WILLIAM G. HYZER
Consulting Physicist
W. G. Hyzer & Associates

MECHANICAL OSCILLATORY MOTIONS AND VIBRATIONS are frequently encountered in the everyday work of the development engineer. A relatively new technique for study of these problems is high speed cinematography. The high speed camera can be more than a visual aid in the observation of rapid motions. With careful method it is an accurate measuring instrument for recording and correlating rapidly changing linear and time data.

Two high speed cameras are commercially available in this country—the Kodak high speed camera and the Fastax, both shown in Fig. 1. Both instruments use standard 16mm film and operate at picture frequencies approaching 3,200 frames per second for the Kodak and 7,500 frames per second for the Fastax. Precise time

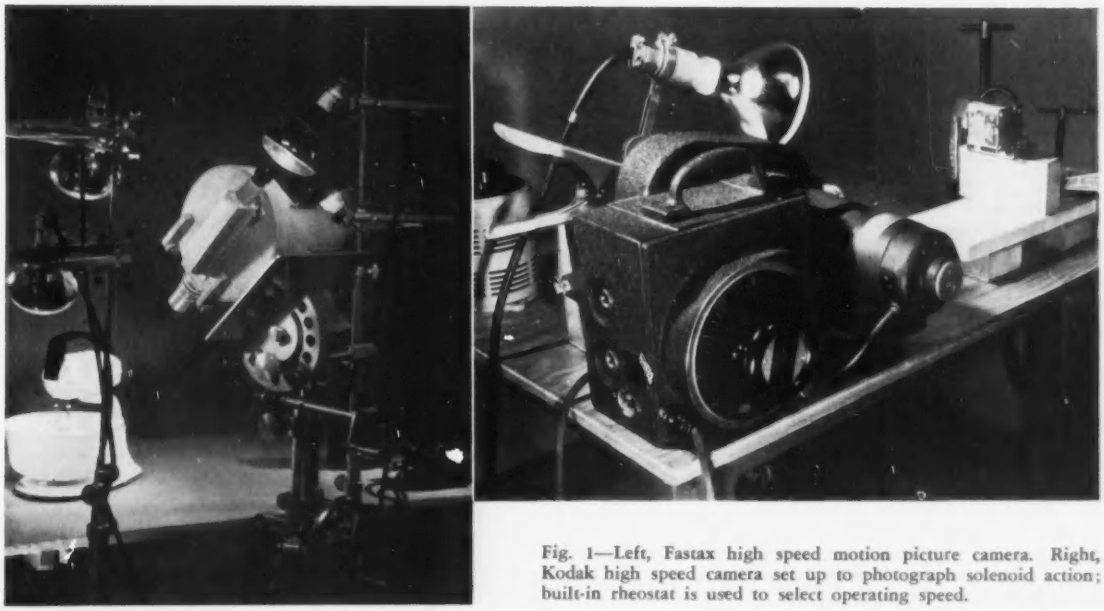


Fig. 1—Left, Fastax high speed motion picture camera. Right, Kodak high speed camera set up to photograph solenoid action; built-in rheostat is used to select operating speed.

interval between successive frames is established in both cameras by exposing timing marks on the edge of the film during normal exposure. Timing exposure is produced by an argon or neon lamp within the camera which is fired by an external alternating current source at a known frequency.

Application of high speed photography to a typical problem in oscillatory motion involves four basic steps:

(1) Photograph the motion at a picture frequency high enough to properly record the important details of the action.

(2) Determine the time interval between frames by measuring the distance between timing mark exposures on the processed film.

(3) Measure image displacement from frame to frame throughout the required duration of the mechanical action.

(4) Correlate the derived displacement and time data in graphical or tabular form.

Fig. 2—Vanguard motion analyzer in which knobs control cross hair movement permits measurements accurate to 0.0002 in. referred to film dimensions.

Timing Accuracy

Accuracy depends upon the experimental procedure used to make the measurements and upon the photographic techniques employed. Assuming that an accurately controlled oscillator is used as a time standard, the absolute time interval between successive frames in a typical run can be measured within ± ¼ per cent. Film velocity through the camera is not constant, therefore, the time intervals between frames at different points along the film are not identical. For highest accuracy average elapsed time between frames is determined for the particular sequence of frames to be analyzed and a curve is plotted which provides a time correction value for each frame in the sequence.

If the picture sequence is taken after the first 20 ft of film have been exposed (where the acceleration is excessively high) and there are 40 frames or less in the sequence, time interval between frames can usually be assumed constant within ± 1 per cent. If 60 cycle current is the standard, an absolute error exceeding ± 1 per cent is not uncommon.

Measuring Accuracy

Frame dimensions of 16mm film are approximately 0.3 in. high by 0.4 in. wide. All linear distances to

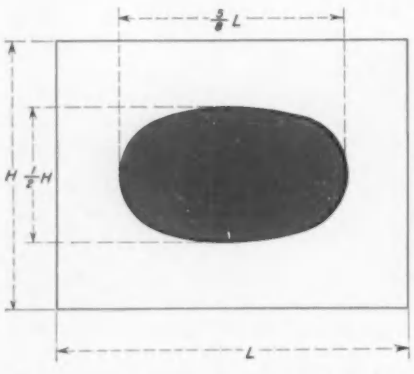


Fig. 3—Central high-resolution area of the high speed 16mm picture frame where distortion is within acceptable limits, permitting measurements accurate to ± 0.0002 in.

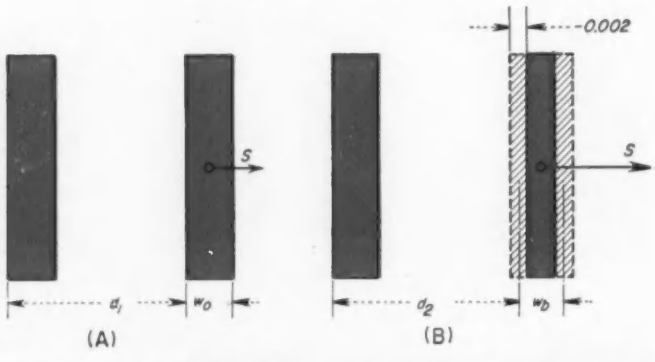


Fig. 4—Effect of image blur upon the resolution of an image reference line. *(A)* Stationary reference line is shown on the left. A moving line with negligible blur is shown on the right. Line width, w_o, is 0.005 in. *(B)* Same two lines, but velocity *(S)* of moving line results in a blur of 0.002 in. Apparent distance between lines is d_2. Apparent line width is w_o.

Table I—Minimum Picture Frequencies for Quantitative Study of Oscillatory Motions

	Vibrational Frequency (V) in cps					
A/W	25	50	100	200	400	800
1.0	4700					
0.7	3300	6600				
0.5	2400	4700				
0.3	1400	2800	5600			
0.1	470	950	1900	3600	7200	
0.07	330	660	1300	2600	5300	
0.05 or less	250	500	1000	2000	4000	8000

Optimum picture frequency, 2 to 2½ times the values listed above, is recommended when accurate image measurements are required.

be measured are recorded within this seemingly scant area of about 0.12 sq in. In the following discussion all measurements are referred to distances on the film except where otherwise noted.

A convenient method of image measurement is provided by an instrument designed for this purpose. The Vanguard Motion Analyzer, shown in Fig 2, projects the film image on a translucent screen at 10 diameters magnification. Micrometer adjusted crosshairs are used to determine image position. Alignment of the crosshairs on the edge of a sharp, high contrast image is reproducible within ± 0.0001 in. In practice, however, optical and film distortion increases the error to approximately ± 0.0002 to 0.0003 in. depending upon the measured length.

For maximum accuracy, images to be measured should be confined to the central region of the frame area as indicated in Fig. 3. Edges of the image should be sharp and of maximum contrast. Best results are obtained by painting a reference line on the moving part and a similar reference line on a stationary part within the field of view of the camera lens. Optimum width of these lines is 1 to 2 per cent of the field width covered by the lens. Reference lines may be either black against white or white against a black background. Both lines should be close to the plane of focus throughout the total amplitude of object displacement. It is advisable to include a graduated reference scale in the plane of focus for purposes of determining image magnification when the films are analyzed.

Image magnification (really reduction) is defined as the ratio of image size to object size. A rough measure of image magnification is obtained by observing the object field width (W) covered by the lens, and dividing this quantity into the width of the 16mm frame (approximately 0.4 in.). An image measurement error of ± 0.0002 in. corresponds to an object measurement error of ± 0.0002/M or approximately ± 0.0005 W in. For example, with a field width of 2 in., object measurements accurate to ± 0.001 in. are possible with this technique. It is common practice to work with field widths down to 0.4 in.

Film Speed

Picture frequency requirements for a rapidly moving object are determined by tolerable image blur as indicated in the following equation:

$$F_{min} = \frac{0.4\ D\ S \cos\theta}{W\ b} \qquad (1)$$

F_{min} = minimum recommended picture frequency in frames per sec
D = duration of exposure for a picture frequency of 1 frame per sec
S = subject velocity in in./sec
W = field width covered by the lens in in.
b = image blur caused by subject motion in in.
θ = angle between the line of motion and the film plane in deg

When the blur becomes greater than 0.002 in. measuring accuracy suffers. This value of image blur is also an acceptable criterion for visual interpretation of projected motion pictures.

Published value of D in Eq (1) is 1/5 for both the Kodak and Fastax cameras. The published value, however, more nearly represents the effective shutter constant in terms of light transmitting efficiency than it does the "motion stopping" performance of the shutter. Corrected values are slightly different for the two cameras and somewhat less than 1/5. A compromise sufficiently accurate for most practical purposes is

$$F_{min} = \frac{60\ S \cos\theta}{W} \qquad (2)$$

This equation serves as a guide in estimating minimum recommended picture frequency when the object velocity and direction are known. Optimum picture frequency is 2 to 2½ times this minimum value.

The equation of simple harmonic motion is

$$x = \frac{A}{2} \sin 2\pi Vt \qquad (3)$$

where

x = instantaneous displacement in in.
A = over-all amplitude of motion in in.
V = vibrational frequency in cps
t = elapsed time in sec

Differentiating Eq (3) with respect to time results in an expression of instantaneous velocity

$$\frac{dx}{dt} = 2\pi V \frac{A}{2} \cos 2\pi Vt \qquad (4)$$

Maximum $\frac{dx}{dt}$ is obtained when the cosine value equals unity

Substituting $\frac{dx}{dt}_{max}$ for S in Eq (1) results in a formula for determining picture frequency with simple harmonic motion:

$$F_{min} = \frac{0.4\ \pi\ D\ V\ A \cos\theta}{W\ b} \qquad (6)$$

In practice, at least 3.5 frames should be devoted to recording a single oscillatory cycle. Where higher harmonics are being studied this 3.5:1 ratio should be applied to the highest harmonic. When it is desirable to obtain a true record of the wave form, the ratio of picture frequency to vibrational frequency should be at least 10:1. Table I is based on Eq (6) as limited by the above rule. It serves as a guide to estimate the picture frequency for a given ratio of amplitude to field width (A/W) and vibrational frequency (V). Where a true visualization of the wave form is not required, picture frequencies approaching 50 per cent or less of the values listed in the table may be used.

Occasionally the vibrating member is translated through space at an appreciable velocity. If the direction of motion is the same as the vibrational direction, picture frequency is estimated by taking the sum of Eq (1) applied to the average velocity, and Eq (6) applied to the oscillatory motion. Picture frequency should normally exceed 10 times the vibrational frequency. One common example of this type of motion is periodic fluctua-

tion in speed of a rotating member, caused by excessive gear chatter in a gear train or torque variation in an overloaded motor. Here the velocity (S) in Eq (1) is the peripheral velocity of the member and the amplitude of vibration (A) in Eq (6) is measured along the circumference of the rotating part.

For the quantitative analysis of any motion of varying velocity, high accuracy of measurement requires special precautions to correct for alignment error introduced by the variation in image blur from frame to frame. This effect is best understood by reference to Fig. 4. At (A) the blur associated with the moving reference line is negligible. The cross hairs can be aligned accurately with the edge of the image. At (B) the image is blurred. An observer will normally align the crosshairs with the apparent mid-point of the blur region. A careful observer can bisect the area of blur with a reproducibility of about ± 5 per cent. However, the point of bisection is at the apparent mid-point of the blurred area which may not coincide with the actual mid-point. This error results from a nonlinear density gradient across the blurred area. Approximate correction for this effect is achieved by subtracting from the image distance $\frac{1}{2}$ $(w_o - w_b)$ where w_b is the measured width of the blurred image, and w_o is the measured width of the image when the blur is negligible.

If the crosshairs have appreciable width, all measurements should be made from the same edge or corrected for crosshair width. In a typical instance, the image was blurred 0.002 in., the correction factor was 0.0003 to 0.0004 in. As a general rule, no correction is required when the blur is less than 0.00075 in.

It is virtually impossible to visually measure the exact size of a blurred image. In a typical case, the actual size of a particular black image was 0.0089 in. Blurred 0.0025 in., the apparent size of the image was reduced to 0.0082 in.

A typical example of harmonic motion is the oscillation of a spring. Normally, it is unnecessary to reconstruct the actual wave form (it can usually be assumed to be simple harmonic motion), but it is desirable to know the vibrational frequency and total amplitude of movement. Applying high speed cinematography to this problem, the first step is to place reference markers at the various points to be measured including a reference line on a stationary member close to the spring. Next, the camera is set up to photograph the action in a position where the film plane is parallel to the object plane containing the various object reference markers. A scale is included in the field of view for later determination of image magnification factor.

Field width (W) required to properly photograph the action in this example is 4 in. Vibrational amplitude (A) is estimated to be about 1/64 in. Frequency of vibration is estimated to be about 250 cps. A/W is approximately 0.004. From Table I suggested picture frequency is 2500 frames per sec. However, since exact wave form will not be plotted, a picture frequency of 800 to 1000 frames per sec is chosen as adequate for this study.

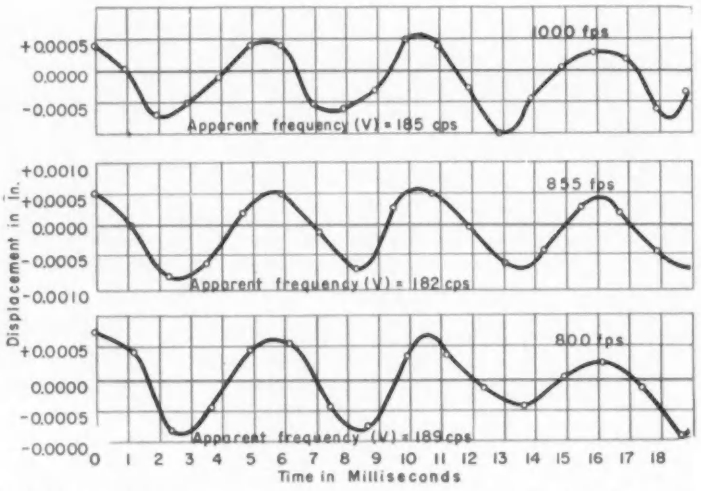


Fig. 5—Actual film measurements of an oscillatory motion. Note that the total amplitude of image displacement is only slightly greater than 0.001 in.

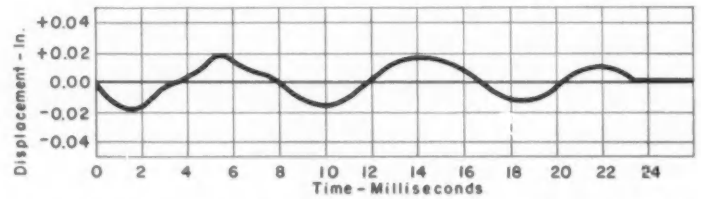


Fig. 6—Vertical bounce and horizontal weave of film through a high speed motion picture camera operating at maximum speed of 7500 frames per second. This is an extreme example.

Fig. 5 illustrates the quality of data obtainable for a problem of this type. The three picture sequences were taken at random points along the film. These sequences consist of 16 to 20 frames. Note that the total image displacement on the film is between 0.0012 to 0.0013 in. Measurement error is approximately ±0.0003 in. Average vibrational frequency determined from the curves is 185 cycles per second ± 2 per cent. Average vibrational amplitude is 0.00123 in., 0.00125 in. and 0.00127 in., respectively. With an image magnification factor of 0.100, the above values become 0.0123, 0.0125 and 0.0127 in. in terms of object dimensions.

Reliable data is obtainable even though measurement error is approximately 25 per cent of the total displacement. Mechanical displacements as small as 1/5 per cent of the field width (W) can be profitably studied with these techniques under favorable conditions.

Reference to Fig. 6 illustrates the

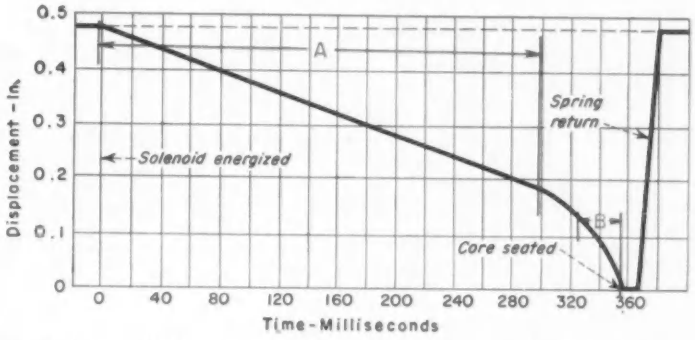


Fig. 7—Average displacement versus time curve of the armature in an ac solenoid.

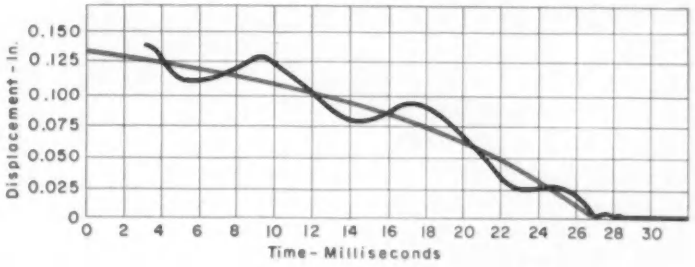


Fig. 8—Magnified view of region *B* in Fig 7. The solid line is the actual displacement curve. The broken line is the average velocity characteristic.

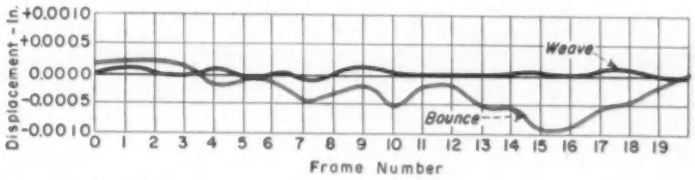


Fig. 9—Vibrational component of the displacement curve shown in Fig. 8.

importance of including a stationary reference mark within the field of view. The curve shows bounce and weave of film in camera relative to a fixed point on the image. Measurement error on the order of ± 0.0007 in. would result if sprocket holes were used as a reference point in this instance.

A solenoid is a common component used in machine controls. Mechanical operation under various conditions of load and excitation are important, but the problems involved in obtaining precise experimental data, usually lead to trial and error methods of adjustment. Quantitative analysis of high speed motion picture films provides a systematic approach to this problem.

Average armature velocity characteristic of a heavily loaded, undervoltaged 60 cycle ac solenoid obtained by photographic analysis is shown in Fig. 7. Voltage is applied to the coil at zero time and the armature is drawn into the field coil at an average velocity of 1.00 in. per sec against the retarding force of a spring. Velocity is constant throughout region A, but increases rapidly in region *B* as the air gap is narrowed. The armature is seated solidly in the coil after a total operation time of 356 milliseconds. Following a dwell time of 10.5 milliseconds, the coil circuit is automatically opened and the spring forces the armature back to its original position at an average velocity of 28.1 in. per second.

Fig. 7 represents the average velocity; actually, the motion of the armature is not uniform but fluctuates in pulses of 120 cps, as shown in Fig. 8, a magnified view of region *B* in Fig. 7. The black curve is the actual displacement of the armature. The curve in color is the average displacement enlarged from Fig. 7. Notice that the armature moves alternately in and out of the field coil, but the average translation is in the direction of the coil.

The oscillatory component of the above velocity diagram is shown in Fig. 9. Over-all amplitude of the oscillation is approximately 0.036 in. Frequency V is about 120 cps. The actual wave form is somewhat distorted by friction but assuming the motion is simple harmonic, maximum velocity of the vibrational component is π A V or 13.55 in./sec. Maximum average velocity indicated by the colored curve in Fig. 8 is 10.0 in./sec. Range of instantaneous velocity in the region *B* becomes 10.0 ± 13.55 in./sec.

Over-all amplitude of oscillation in region A is somewhat less, with a range of instantaneous velocity of − 3.5 to + 5.5 in./sec and an average velocity of 1.0 in./sec.

Field width (W) used in this study was 1.6 in. Maximum armature velocity takes place during the spring return phase of the cycle. At this point of the action S = 28.1 in./sec.

$$F_{min} = \frac{60\ S}{W}$$

$$= \frac{60 \times 28.1}{1.6}$$

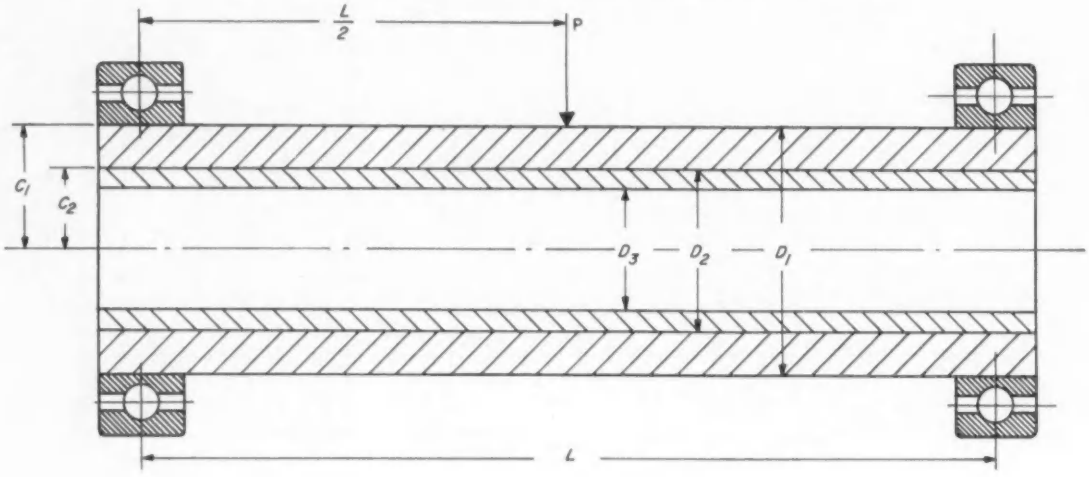
$$= 1{,}050 \text{ frames per sec}$$

Optimum picture frequency is about $2\frac{1}{2}$ F_{min} or about 2,600 frames per sec. Picture frequency used was 2,800 frames per sec.

EDITOR'S NOTE: Another example of the use of high speed photography may be found in an article entitled "Dynamic Loading of Compression Springs," by Karl W. Maier in *Product Engineering*, Jan. 1954, p 163. Here time displacement data are plotted for each coil of an accelerating spring.

In Sept. 1952 *Product Engineering* published a review of "High Speed Photography in Design," by C. David Miller and Kenneth Shaftan on p 167. Basic considerations included cost of equipment, event duration, types of photographic record, repetition rate, exposure duration and time scale. Operation and characteristics of major cameras were discussed and typical applications included knock in piston engine, vibration in structures and fluid flow through an impeller.

Fig. 1—Typical composite member—a machine roller used in textile machinery.



Designing COMPOSITE MEMBERS

REINER J. AUMAN
Design Engineer, Kerns Manufacturing Corp.

Stress and deflection formulas for members made of materials with different elastic modulus values; graphical solution for composite members of unequal length or homogeneous members of varying cross section.

SYMBOLS

A	= cross-sectional area, in.^{2}
c	= distance to outermost fibre, in.
D	= diameter, in.
E	= modulus of elasticity, psi
G	= shear modulus of elasticity, psi
I	= moment of inertia, in.^{4}
J	= polar moment of inertia, in.^{4}
L	= length, in.
M	= bending moment, in.-lb
P	= concentrated load, lb
P_i	= internal pressure, psi
r	= radial expansion, in.
S	= unit stress, psi
t	= thickness of pipe, in.
T	= torsional moment, in.-lb
w	= uniformly distributed load, lb/ft
y	= deflection, in.
θ	= angle of twist, rad

MECHANICAL AND STRUCTURAL MEMBERS composed of several materials are frequently encountered in machine rollers, compression members and beams. Designing such members for maximum strength and minimum cross section requires modification of the standard deflection formulas.

Deflection Formulas

First step in modifying a standard deflection formula is choosing the boundary conditions so that the deflection curvatures of the different materials are equal. For example, if the composite roller in Fig. 1 is analyzed for maximum deflection, the boundary conditions are as follows (subscript 1 represents outer member; subscript 2, inner member):

$$y'' = \frac{d^2 y}{dx^2} = \frac{M_1}{E_1 I_1} = \frac{M_2}{E_2 I_2} \qquad (1)$$

Solving for M_1 and M_2:

$$M_1 = y''(E_1 I_1); M_2 = y''(E_2 I_2) \qquad (2)$$

Fig. 2—Graphical method for determining the deflection and stresses of a composite section with unequal lengths.

Adding both equations results in:

$$M_1 + M_2 = y'' (E_1 I_1 + E_2 I_2) \quad (3)$$

or

$$y'' = \frac{M_1 + M_2}{E_1 I_1 + E_2 I_2} \quad (4)$$

However, the total applied moment is equal to:

$$M = M_1 + M_2 \quad (5)$$

Therefore, the general equation for two different materials and cross-sections is

$$y'' = \frac{M}{E_1 I_1 + E_2 I_2} \quad (6)$$

and for n different materials and cross-sections

$$y'' = \frac{M}{\sum_{i=1}^{n} E_i I_i} \quad (7)$$

Applying the double intergration method (see "Strength of Materials," Boyd and Folk, McGraw-Hill Book Co., Fifth Edition page 154) to Eq (7) gives the following deflection formula for bending.

$$y = \frac{P L^3}{48 \sum_{i=1}^{n} E_i I_i} \quad (8)$$

The above procedure indicates that the deflection of a composite beam under any type of loading can be determined by replacing the EI term of the standard deflection formula with the summation term,

$$\sum_{i=1}^{n} E_i I_i,$$

of the composite section. Table I gives several typical examples of composite beams under bending loads.

Stress Formulas

Equations for the bending stress on each member of the composite section in Fig. 1 can be derived as follows:

$$M_1 = \frac{S_1 I_1}{c_1}; M_2 = \frac{S_2 I_2}{c_2} \quad (9)$$

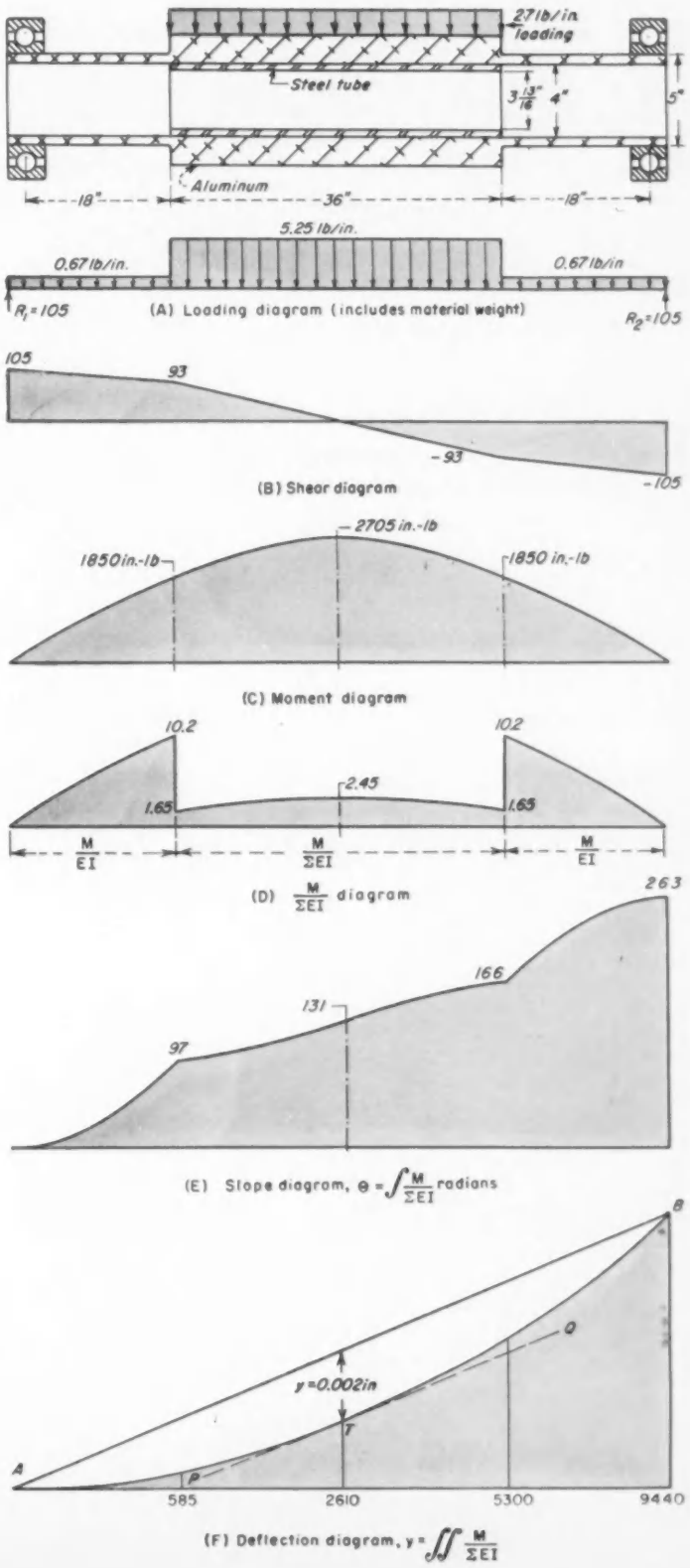


Table I—Modified Stress and Deflection Formulas for Composite Members

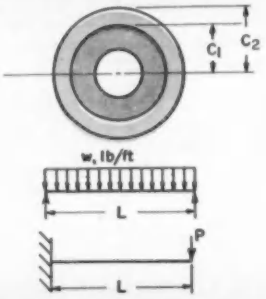
BENDING

$$S_1 = \frac{M c_1 E_1}{E_1 I_1 + E_2 I_2}$$

$$S_2 = S_1 \left(\frac{c_2}{c_1}\right)\left(\frac{E_2}{E_1}\right)$$

$$y = \frac{5 w L^4}{384 (E_1 I_1 + E_2 I_2)}$$

$$y = \frac{P L^3}{3 (E_1 I_1 + E_2 I_2)}$$

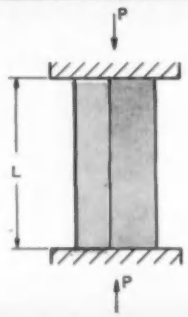


COMPRESSION

$$y = \frac{P L}{A_1 E_1 + A_2 E_2}$$

$$S_1 = \frac{P E_1 S_1}{A_1 E_1 + A_2 E_2}$$

$$S_1 = S_2 \frac{E_1}{E_2}$$

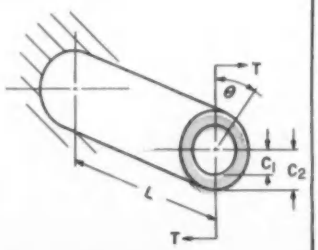


TORSION

$$\theta = \frac{T L}{G_1 J_1 + G_2 J_2}$$

$$S_1 = \frac{T c_1 G_1}{G_1 J_1 + G_2 J_2}$$

$$S_1 = S_2 \frac{G_1 c_1}{G_2 c_2}$$



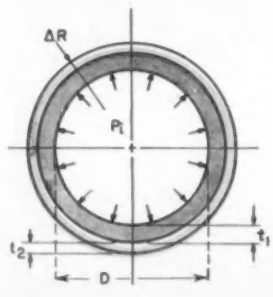
INTERNAL PRESSURE

$$\Delta R = \frac{P_i D^2}{4 (E_1 t_1 + E_2 t_2)}$$

$$P_i = \frac{2}{D} (S_1 t_1 + S_2 t_2)$$

$$S_1 = \frac{P_i D E_1}{2 (E_1 t_1 + E_2 t_2)}$$

$$S_1 = S_2 \frac{E_1}{E_2}$$



Substituting the above values of M_1 and M_2 into Eq (1) gives:

$$\frac{S_1}{c_1 E_1} = \frac{S_2}{E_2 c_2} \tag{10}$$

or

$$S_2 = \frac{S_1 c_2 E_2}{c_1 E_1} \tag{11}$$

Introducing the total moment gives

$$M = M_1 + M_2 = \frac{S_1 I_1}{c_1} + \left(\frac{S_1 c_2 E_2}{c_1 E_1}\right)\frac{I_2}{c_2} \tag{12}$$

$$M = \frac{S_1}{c_1}\left(I_1 + \frac{E_2 I_2}{E_1}\right) \tag{13}$$

or

$$S_1 = \frac{M c_1 E_1}{I_1 E_1 + I_2 E_2} \tag{14}$$

The same procedure can be followed for S_2 resulting in:

$$S_2 = \frac{M c_2 E_2}{I_1 E_1 + I_2 E_2} \tag{15}$$

from which

$$\frac{S_1}{S_2} = \left(\frac{c_1}{c_2}\right)\left(\frac{E_1}{E_2}\right) \tag{16}$$

For more than two materials, the general stress equation becomes:

$$S_i = \frac{M c_i E_i}{\sum_{i=1}^{n} E_i I_i} \tag{17}$$

Stress Ratio

Eq (16) is useful in determining the minimum permissible cross-sections when the maximum working stress for each material is known. This prevents one material from carrying too small a load in proportion to its cross-section.

For example:

The following values may be assumed for an aluminum roller, such as shown in Fig. 1, with a steel inner tube: $E_s = 10 \times 10^6$, $E_a = 30 \times 10^6$, $S_s = 10{,}000$, $S_a = 20{,}000$, $M = 10{,}000$.

From Eq (16):

$$c_2/c_1 = 0.666 = D_2/D_1$$

Assuming that an outside diameter of 4.5 in. must be maintained, the dimensions of the steel tube are determined as follows:

$$D_2 = 0.666\ (4.5) = 3.0$$

$$c_2 = 1.5$$

However

$$I_1 = \pi(D_1^4 - D_2^4)/64; I_2 = \pi(D_2^4 - D_3^4)/64$$

Therefore, from Eq (15)

$$20{,}000 = \frac{10{,}000\ (1.5)\ (30)}{\frac{\pi}{64}\left[10(4.5^4 - 3^4) + 30(3^4 - D_3^4)\right]}$$

Solving for D_3 results in:

$$D_3 = 2.4 \text{ in.}$$

Thus both materials will be stressed at the intended maximum working values.

Similar analyses of other loading conditions besides bending, such as compression, torsion, and internal pressures in cylinders result in the modified equations shown in Table I.

Composite Sections With Unequal Lengths

Bending problems involving composite sections with unequal lengths or homogeneous members with varying cross section are best solved by graphical means. A typical problem is shown in Fig. 2. It is desired to determine the location and magnitude of the maximum deflection and the induced bending stresses.

Loading diagram (A) includes the weight per inch of the roller. After the reactions R_1 and R_2 are determined by taking moments around R_1 and R_2, the shear diagram (B) and moment diagram (C) is constructed in sequence. Diagram (D) is obtained by dividing the moment values by either $E\,I$ or $\Sigma\,E\,I$, depending on the section being evaluated. Graphical integration of (D) results in the slope diagram (E); integration of the slope diagram determines the deflection diagram (F). Actual beam deflection is the vertical distance between curve $A\ T\ B$ and straight line $A\ B$. Point of maximum deflection T can be obtained by constructing a line (PQ) parallel to line $A\ B$ and tangent to curve $A\ T\ B$. This locates point T. Maximum deflection, by measurement, is 0.002 in.

Stress values of $S_{alum} = 85.5$ and $S_{steel} = 146.5$ are obtained by substituting the maximum moment ($M = 2705$) from diagram (C) into Eqs (14) and (15).

Electronics and the West

In a recent talk, H. Leslie Hoffman, President, of the Hoffman Electronics Corp., Los Angeles, Calif., pinpointed the electronics industry, where it is, where it is going, and some of the problems facing its growth. The following are some of the highlights.

Today, the industry is nearly as diverse as its scope is broad. It provides employment for more than 1¾-million people. Today 2.7 per cent of the working population is employed in the electronics industry, while 10 years ago 75 per cent of these jobs did not even exist. At the end of 1955, the electronics industry was producing equipment and services at an annual rate of $9-billion. The grand total for the industry has increased 81 per cent since 1950, and by 1960 is expected to reach $15-billion.

Since 1951, military electronics has accounted for the greatest percentage of the manufacturers' dollar volume at the factory level, as well as an increasing percentage of the national defense budget. Commercial and industrial electronics production is just beginning to come into its own.

Mr. Hoffman stated that the total number of manufacturers of electronic end equipment, components and hardware in 1955 was estimated at 3600. Of these, 1000 firms produced end equipment or major subassemblies of some type in the entertainment, commercial or military fields. Component manufacturers totalled about 2000 while the remaining 600 companies produced such related hardware as antennas, brackets, switches, shafts, knobs, wiring harness, and others. Despite the large number of companies in the industry, about 50 manufacturers are estimated to account for over 80 per cent of the dollar volume of end equipment production.

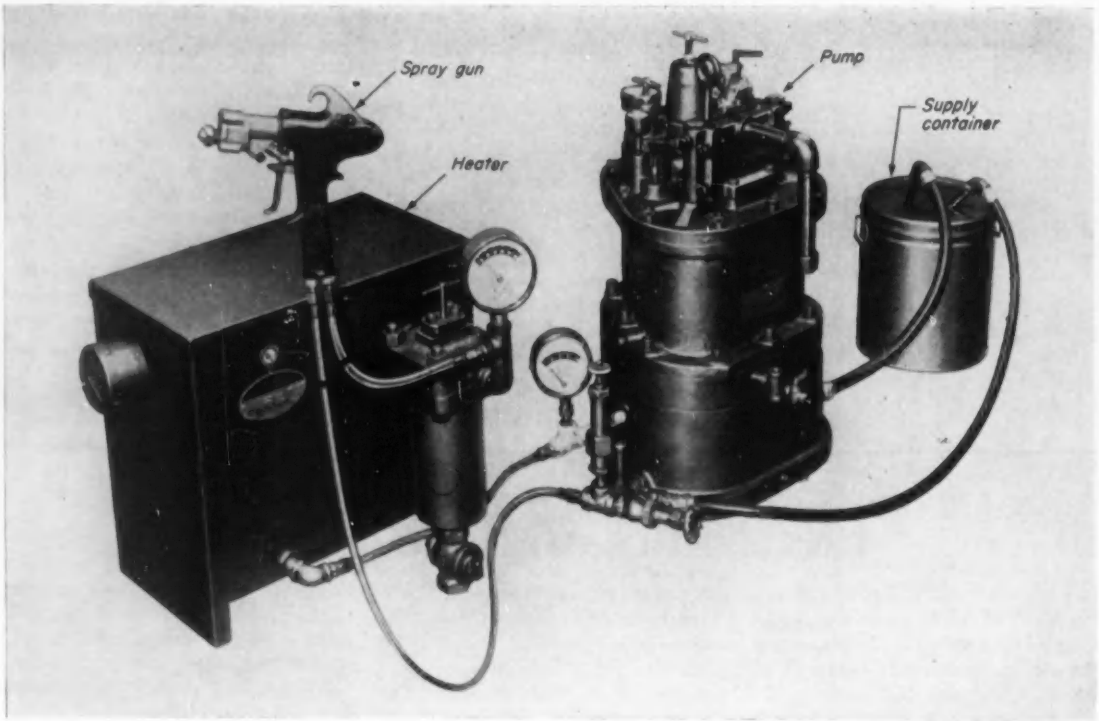
Mr. Hoffman, whose company is located in the Los Angeles area, says that there is little doubt that electronics expanded faster in Los Angeles than in the nation as a whole. During the past 5 years, employment in electrical machinery, equipment and supplies expanded 177 per cent there, as compared to 32 per cent nationally.

The capital investments in new electronic plants and expansions announced for Los Angeles county totalled over $900-million. Larger than any other industry, it almost doubled the amount expended by the aircraft industry, and amounted to 18.4 per cent of the total for all manufacturing industries combined.

Mr. Hoffman, in pointing to the growth of the electronics industry in Southern California and the West, said that a contributing factor will be the tremendous increase in population. He added that the West's greatest electronic growth will be in the new fields of nuclear energy, solar energy, missiles, satellites, communication, navigation and rockets. Along with that, electronics companies in the West Coast area should maintain their leadership in the advanced design and production of consumer service goods such as computers and other data processing equipment. Whether the electronics industry will continue to grow at its present rate in the Los Angeles area depends upon the military's policy of dispersal.

One of the most critical problems facing the electronics industry today is how to get more engineering output in industry. To help accomplish this, engineering must be improved qualitatively. Management must make it possible for the engineers to spend more time on engineering work and less on miscellaneous paper work. One way would be to establish a uniform drafting procedure for manufacturing drawings that was recognized by all three Services and industry. More concise and pertinent specifications would add to the engineers' efficiency.

"Opportunities exist today such as they have never existed before for the engineer. Business no longer looks at engineering as a necessary evil. The engineer has become an essential element for the growth of any company."

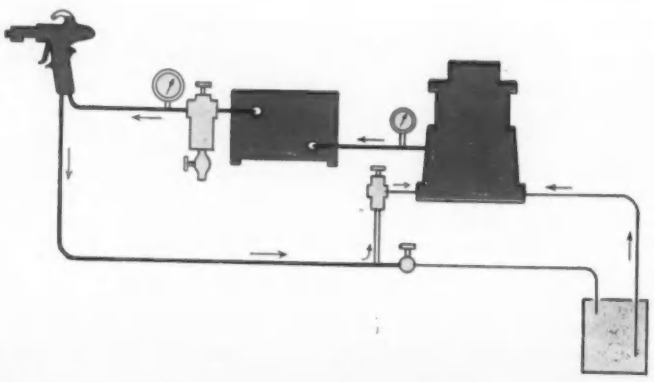


HEATING PAINT to lower its viscosity and atomizing with hydraulic pressure allows application of heavier paint that builds film faster. Better fan size control and less overspray are obtained. The hot paint dries quickly as it has a low amount of solvent. Since paint pigments are very abrasive, equipment for pumping and spraying, including hose lines, must be designed to resist abrasive wear. Also, paint solvents dissolve materials used as seals and are more active at the high temperatures used for airless spraying. Teflon hose lining and seals prevent excessive wear from pigment abrasion and solvent action.

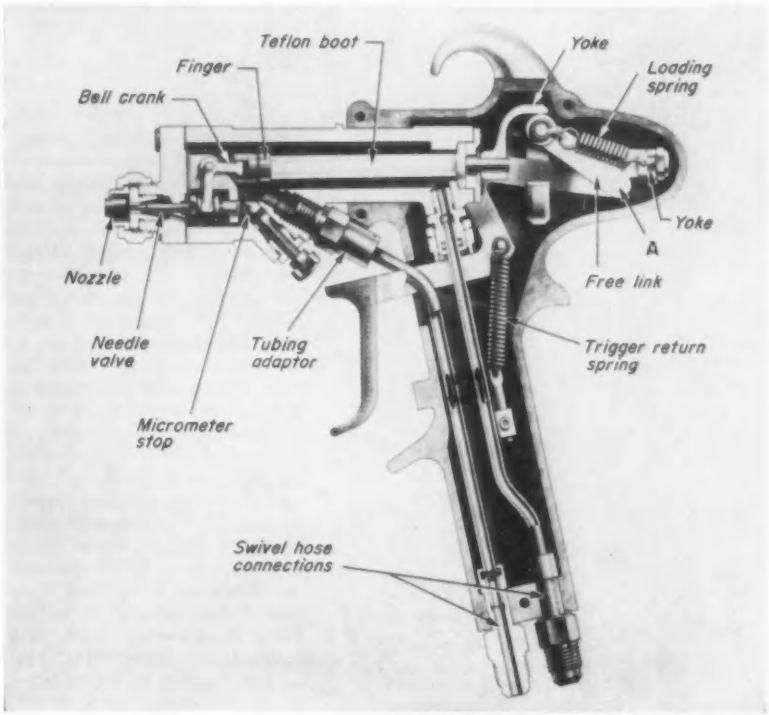
Continuous circulation through pump, gun and heater maintains paint temperature at all loads. The paint sprayed is only a small proportion of the pump output. Paint drawn from the supply container is rapidly heated by mixing action.

Hydraulic Pressure Atomizes Paint

SPRAY GUN incorporates a throttling valve in series with the nozzle to start and stop gun. Experience demonstrated snap-action valve opening prevents initial ejection of unatomized paint by producing rapid pressure build-up at the nozzle; opening action must occur in less than 0.05 sec for satisfactory operation. Finding packing suitable for the operating temperatures and able to withstand the action of abrasive pigments and hot solvents was another major design problem. Packing glands used as seals with both reciprocating and rotary valve operators were unsatisfactory at 1000 psi and 250 deg. F. Motion of valve stem caused severe gouging—then leaks. Seals had to be so tight that static friction prevented rapid opening. The final design uses a snap action triggering device and a flexing seal to avoid these obstacles.

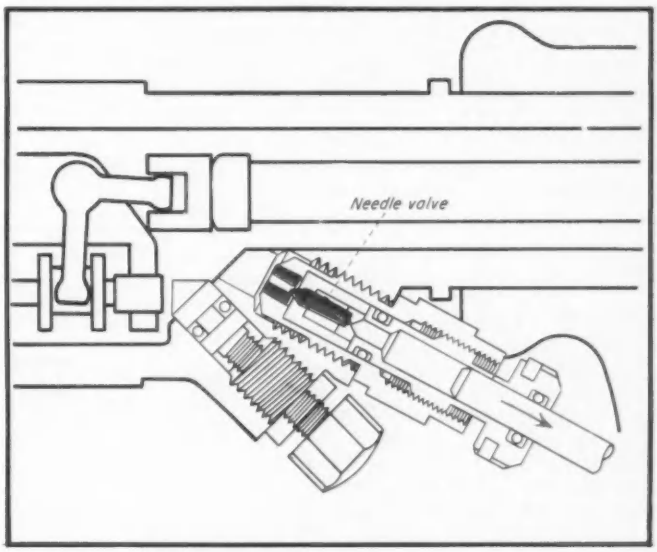


IN NEW PRODUCTS

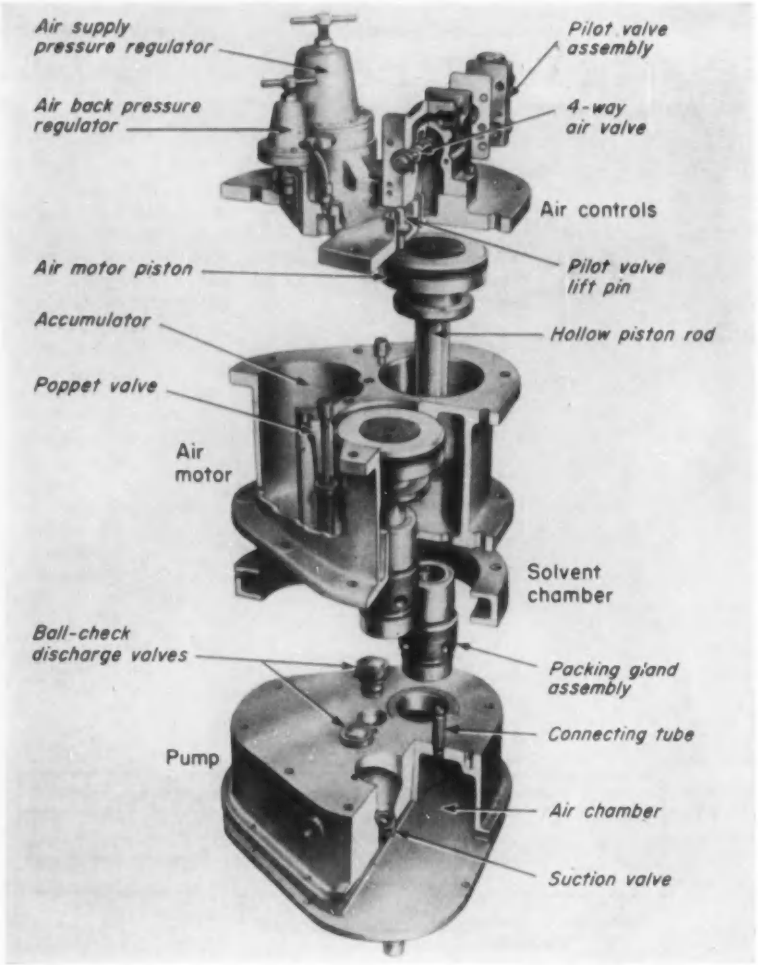


A FREE-LINK snap-action linkage maintains maximum spring forces during triggering action to hold valve in position until rapid motion occurs. Trigger arm moves free link to place pivot A on opposite side of loading spring center line; opposite end of link now snaps to lower position, reversing movement on yoke and finger assembly. Snap motion is transmitted to the needle valve through a bell crank; valve opening is limited by a preset micrometer stop. The mechanism is self contained and may be removed from the handle as a unit. A teflon boot serves as a flexible sealing membrane which avoids motion relative to linkage. The boot is supported by finger and clamping plate and cannot be deflected by pressure. Linkage position is independent of pressure as the only unbalanced force is pivot load from cross-sectional area of finger.

A spray gun triggered by snap-action linkage, a reciprocating pump without discharge fluctuation and a heater using aluminum castings to transfer heat form a system for airless spraying of abrasive paints. Each component was designed by Bede Products Corp., Amhearst, Ohio, to avoid the action of abrasive pigments and hot solvents on seals and moving parts.

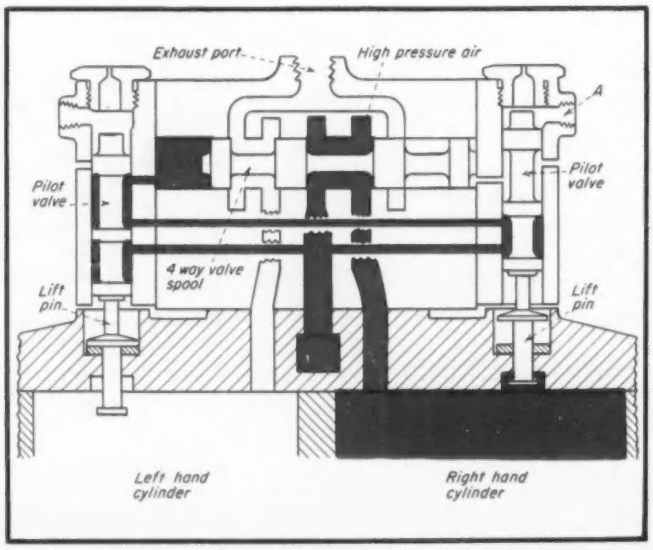


WHEN A SINGLE PUMP supplies several guns with different hose lengths, a tubing adaptor in each recirculating line is replaced by an adjustable valve. Valves equalize paint flow by absorbing sufficient pressure to make line losses negligible; this maintains constant paint temperature at all guns. Hose connections swivel in handle to increase maneuverability while decreasing fatigue. Teflon "O" rings seal where rotary motion occurs; other "O" rings are synthetic rubber. Hose is teflon lined to prevent abrasion from low velocity flow of pigments. Glass reinforced plastic is used for handle and grip parts for heat insulation and weight reduction; gun is 20 per cent lighter than previous designs. The triggering force is held approximately constant by the combined action of the return and loading springs.

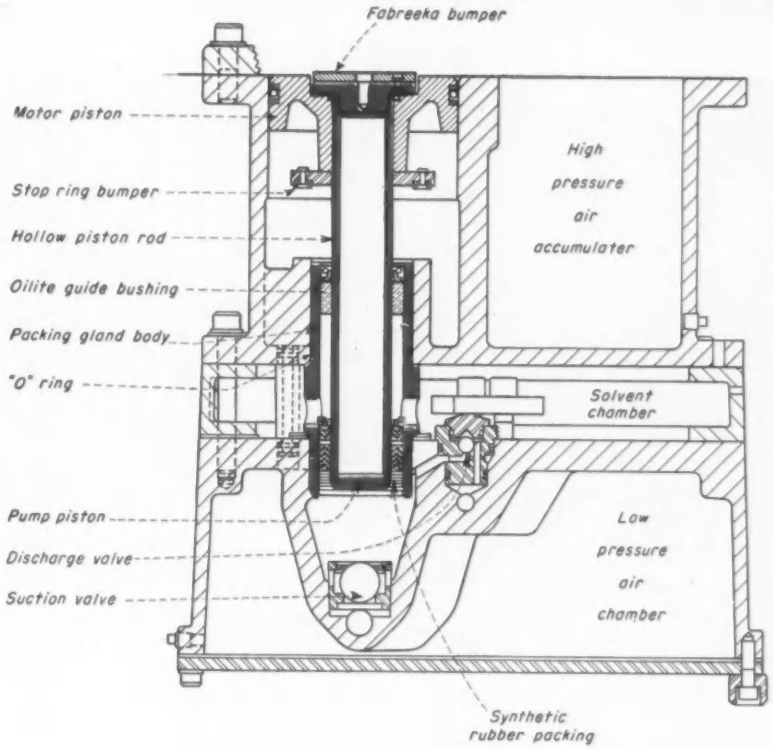


THE PUMP must operate without pulsations at all loads to maintain a relatively constant fan pattern and paint flow rate. This is accomplished by using an air powered reciprocating piston motor with special valving for the required sequential operation of the two pump pistons. The suction stroke is faster than the pumping stroke so one of the pistons is always discharging fluid. The pumping unit is designed as 4 sections: air controls, air motor, solvent chamber and paint pump.

A section of the air motor housing, used as an accumulator, supplies peak demands at relatively constant pressure. Air trapped beneath motor pistons powers the suction stroke; all available space is used as a common chamber, a regulating valve holding the pressure within set limits. Paint pressure of 500 psi is obtained by pumping with 60 psi air and using 10 psi air to power the suction stroke.

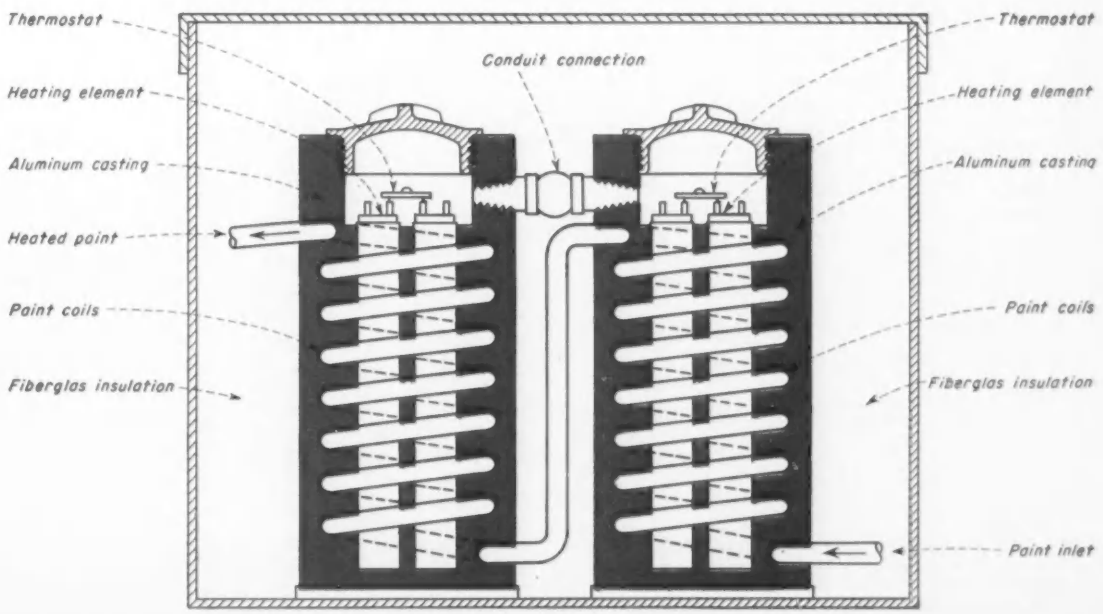


THE PILOT operated 4-way air valve controls pumping stroke sequence. When the piston in the left hand cylinder is starting the upward suction stroke, the spool is positioned by pilot air pressure fed to the left end as indicated. The pilot valve is pushed upward when the piston completes its stroke, connecting the left end of the spool to atmosphere. Before the pumping piston completes its stroke, it actuates the poppet valve, directing air to A to push right-hand pilot valve down and move spool to opposite position, reversing cycle. Spool motion does the following in sequence: the air supply to the right-hand piston is blocked; air is admitted to left-hand cylinder, starting pumping stroke; right-hand cylinder exhausts after left-hand cylinder starts pumping. Paint flow is maintained by expansion of air in pumping cylinder after supply is blocked.



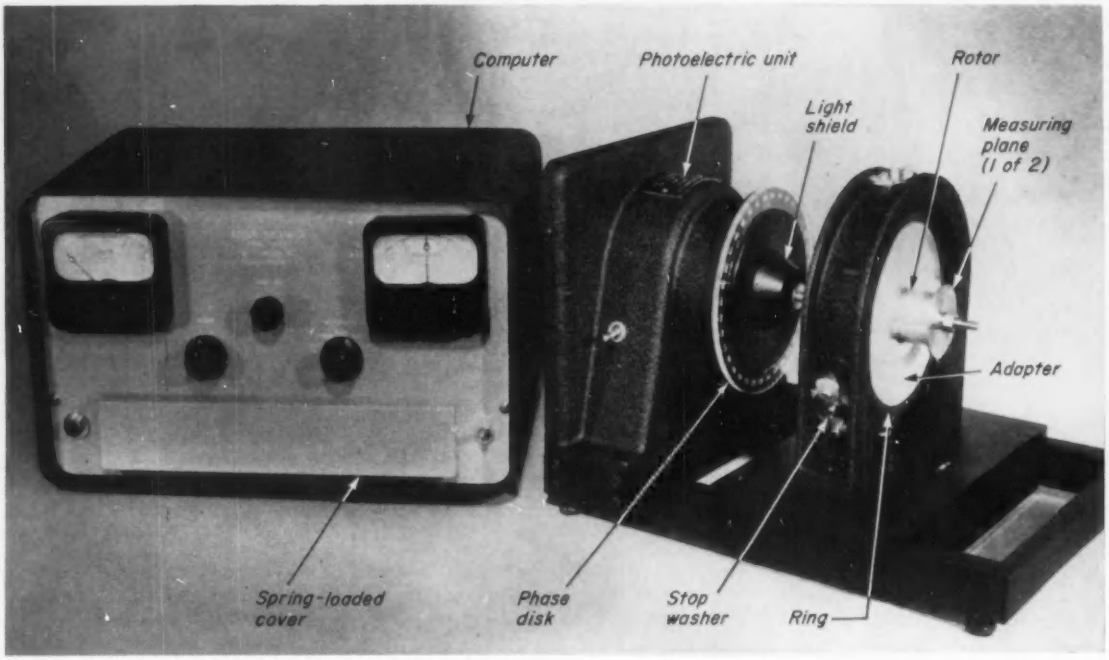
THE AIR MOTOR and pumping sections are aligned by the cylinder packing gland assemblies. The special synthetic rubber packings, used for the solvent and temperature environment, have poor elastic properties; cylinder and gland bores are machined simultaneously for accurate alignment to prevent permanent deformation and subsequent leakage. The tolerance build-up at joints between the solvent chamber and the motor and pump housings prevents clamping the packing gland between them. Relative motion that would destroy the "O" ring seal is prevented by spring loading the assembly against the air motor casting with modified belleville springs. Hollow piston rods reduce inertia and heat transfer between hot paint and air motor. The rods are chrome plated and polished to a 3 micron finish to keep faults small relative to pigment particles that might be imbedded in moving rods.

HEATER PAINT COILS are cast in the aluminum blocks; the heating elements and thermostat are pressed into machined sockets. Using aluminum as the heat transfer medium prevents corrosion and loss problems while maintaining good transfer characteristics with adequate heat storage capacity. Boundary layer effects between transfer medium and tubing are avoided; heat flow to coils is uniform. Paint stream is uniformly heated close to the maximum allowable temperature by using large surface area and a low temperature differential. Lower surface tension and viscosity of heated paint produces finer particles when atomized; flashing of solvent heated under pressure further reduces particle size. Two heating elements are used in each casting to allow series or parallel connection for either 110 or 220 volt operation.



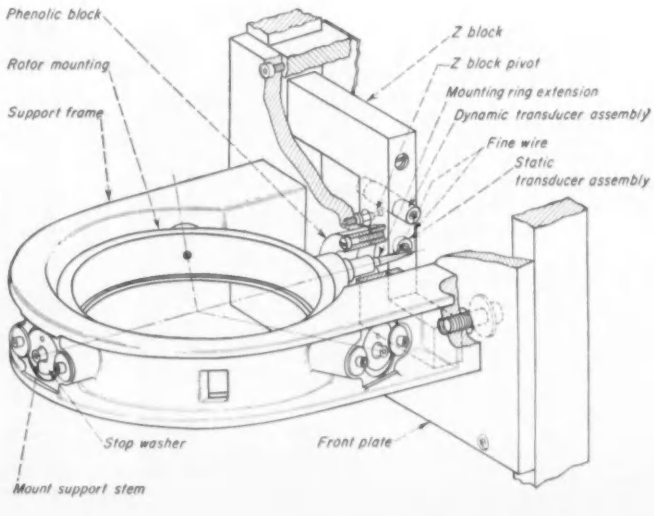
Balancer Operates To 200,000 Rpm

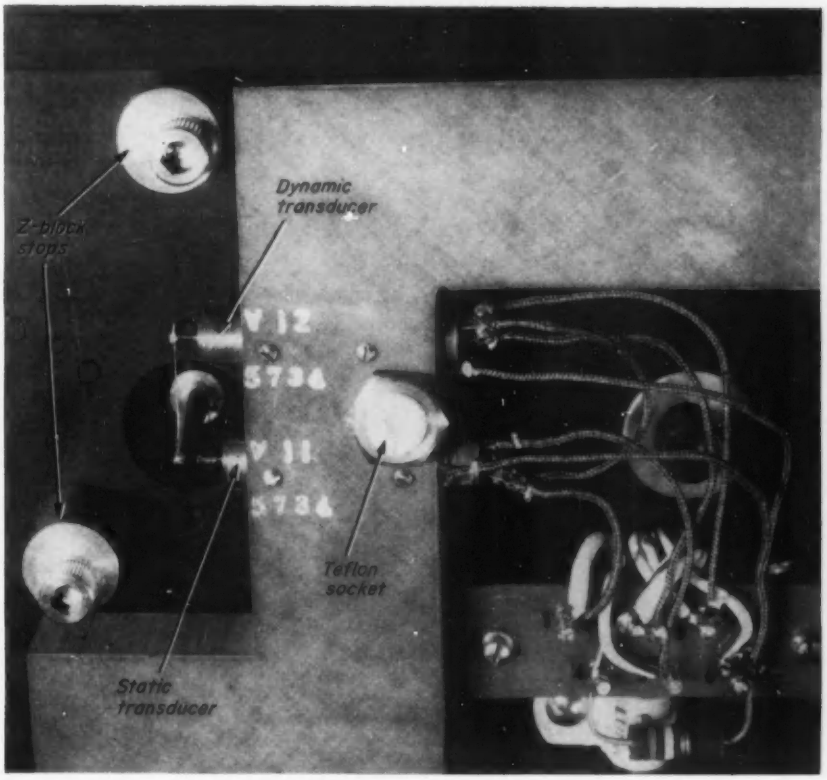
A balancer to test rotors at speeds of 1000 to 200,000 rpm has been developed by M. Ten Bosch, Inc., Pleasantville, N. Y. This range is made possible by two transducers, a broad-band demodulator and a photoelectric phase sensing system which are independent of frequency over a wide range. The unit operates with vertical or horizontal spin-axis mounting.



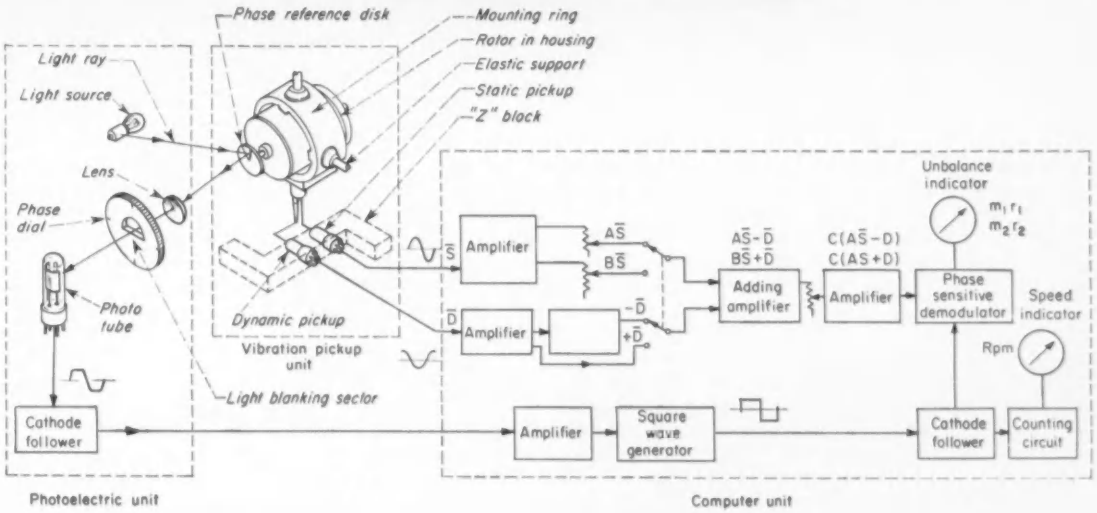
THE PICK-UP AND COMPUTER UNITS are separated to obtain mounting and remote control flexibility. Rotor shown under test simulates field mounting conditions with pick-up unit in horizontal position. The balancer can be operated remotely with a servo motor controlled by the unbalance signal; the motor would drive the phase dial which determines the amount and location of the unbalance. The rotor mounting assembly (ring and adaptor) is made of magnesium for low inertia to obtain high sensitivity. A hinged cover on the front of the computer housing is spring-loaded to protect controls used only to setup the unit.

ROTOR MOUNTING RING (shown in vertical position) is supported by three rubber multiplaner mounts. A rubber mount was selected for damping characteristics and low resonant frequency. Each mount is supported on a stem centered in a stop washer; this arrangement allows a slight ring movement in the vertical plane. Each stop washer is locked by two smaller washers, which are screw-adjusted through slots in the support frame.





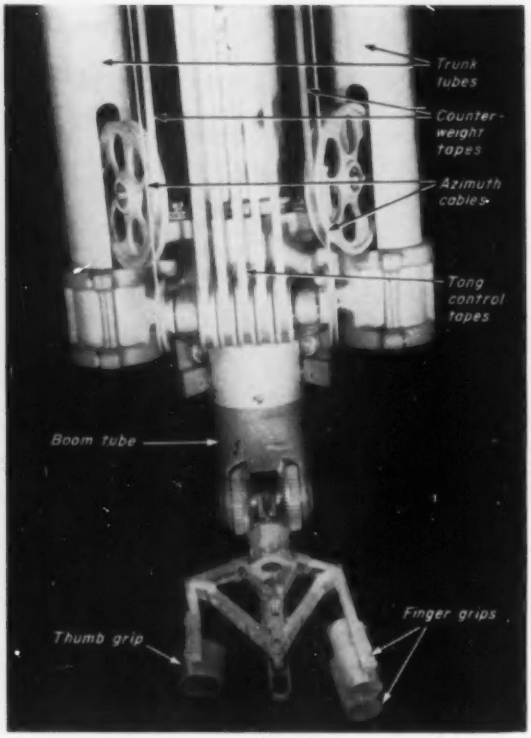
TWO TRANSDUCERS (measuring static and dynamic rotor displacement) are mounted in a Z-shaped phenolic block. Static displacement is a measure of the mass unbalance; dynamic displacement indicates its angular position. Block's Z-shape gives high inertia with center of gravity at pivot. The block adjusts for rotor weight by pivoting on a ball in a Teflon socket.



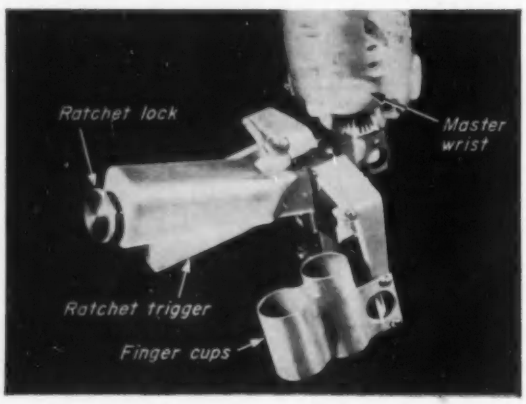
DISPLACEMENT SIGNALS ARE amplified and discriminated against a square wave reference voltage; the square wave is used to accurately time the signals entering the demodulator. The light-blanking sector of the rotating phase dial controls the time phase of the reference voltage relative to rotor position. The unbalanced mass is computed from the indicator reading, and the angular position is read from the phase dial with respect to the white sector on the reference disk. Measurements are made at two arbitrary planes through the rotor; the inverter is used to obtain a phase relation between the two displacement signals obtained at one of the two planes. The demodulator filters all spurious frequencies in the operating range except odd harmonics of the rotor frequency; absence of tank circuits in computer contributes to broad test-frequency range. A vacuum phototube is used for wide band frequency response, with a cathode follower serving as an impedance transformer. Heavy filament automobile bulbs are used for their low resonant frequency.

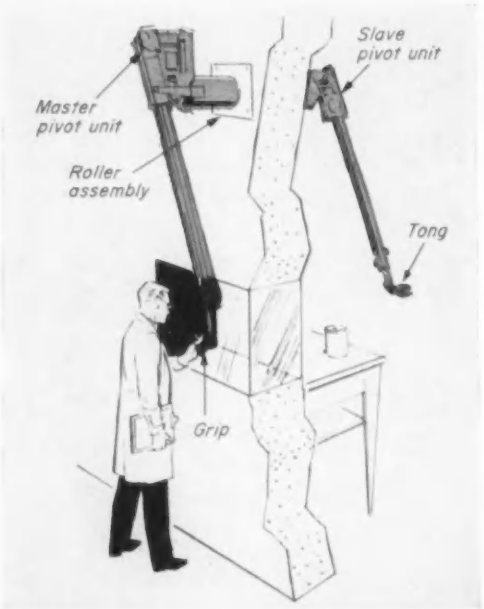
Manipulator Redesigned for Production

Originally developed by Argonne National Laboratory for handling radioactive materials from remote locations, this master-slave manipulator has been refined for mass production by the Engineering and Manufacturing Division of American Machine and Foundry Company. Extensive use of precision castings, careful selection of materials and well thought out production and assembly procedures resulted in a precise flexible unit of relatively low cost.

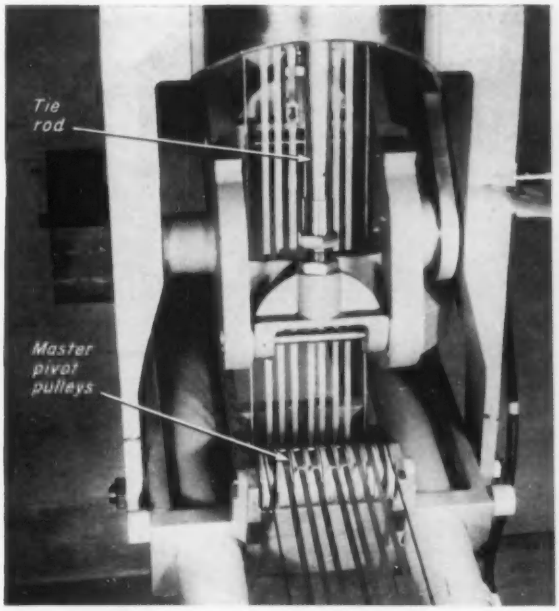


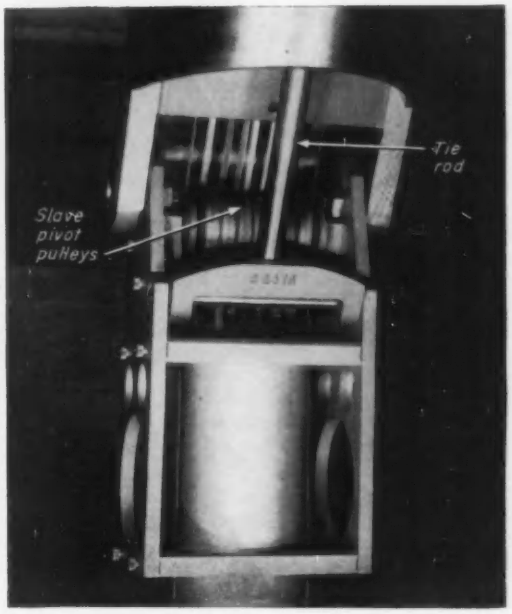
GRIP DESIGN required knowledge of hand shapes and sizes, what causes fatigue and how to reduce it. The canting switch is mounted on the trunk tube where it can be operated with the free hand. The ratchet lock-out is placed at the end of the grip handle and is also worked with the free hand. The ratchet trigger is in the handle bottom and is held by the little finger of the hand in the grip. The finger grips and linkage are precision aluminum castings. Differential gears are precision machined from 75ST-6 aluminum and are clear anodized; they are not lubricated. Stainless steel is used for all shafts and pins; close tolerances are necessary in both master and slave wrist assemblies to control lost motion. Aircraft type wire cable is used to prevent slippage from elongation and stretch. Fatigue stress considerations required use of solid rectangular sections in grip links in place of "I" sections originally selected for optimum use of material.





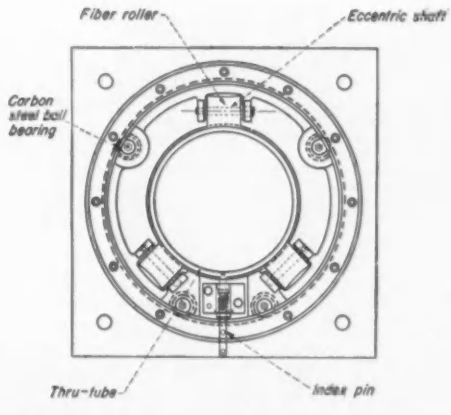
HAND MOTIONS ARE TRANSMITTED from the master end to the slave end by 7 tapes and 2 cables. Actions include gripping, rotation or azimuth motion, twisting or wrist action, extension or "Z" motion and turning which is a second wrist action. To let operator handle weights from 5 to 30 lbs in various positions with little fatigue, counter-weights balance arms in all positions. A greaseless ball bearing unit has been developed to support each end of the thru-tube to keep friction forces low. Unit was made in lots of 2 to 4. Most parts were machined from solid stock; a few parts were sand cast. It is now designed for quantity production with permanent mold castings replacing sand castings and machined parts.



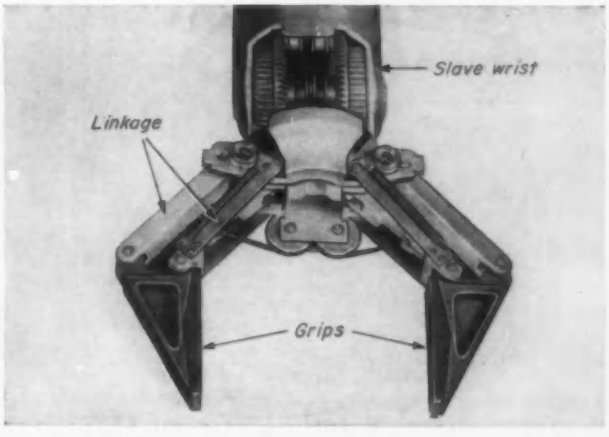


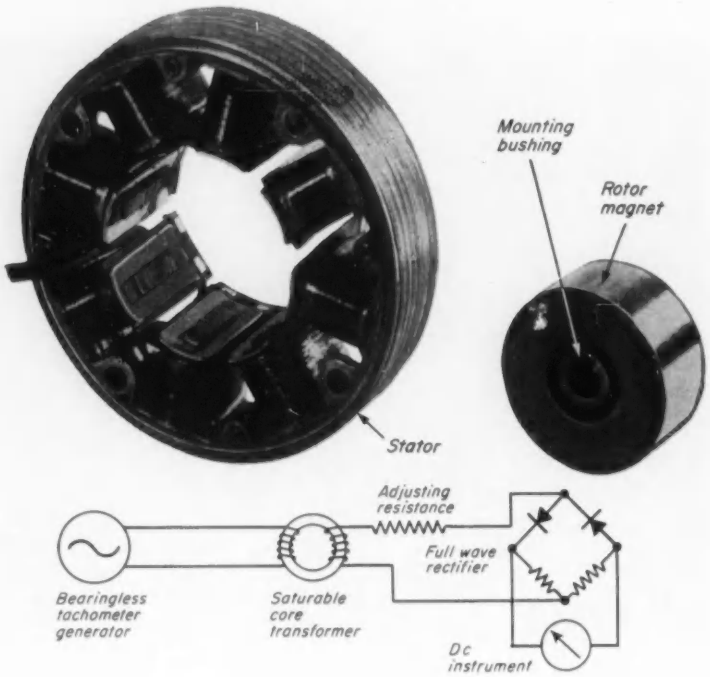
THE PIVOT UNITS are designed to maintain accurate position relationships. The pulleys are arranged to keep the tape taut in all positions to prevent slack and consequent lost motion. Tapes are used instead of cables to obtain a compact design although they cost more. Smaller diameter pulleys can be used and the tapes will stay centered on a relatively narrow crown. They are made of special alloy spring steel with a tensile yield stress of 160,000 psi. A tie rod connects the two arms through the thru-tube and reproduces master end motion at the slave end with a parallelogram linkage. Counter-weights for the master arm are above the pivot unit at the master end and are attached to the trunk tube extensions. An electric motor drive varies the relative angular position of the arms; the motor reaction member also serves as a counter-weight for the slave arm.

THE THRU-TUBE BEARING must operate without grease that would become radioactive and endanger personnel when the manipulator is removed for repairs. Clearances are adjusted at assembly to allow smooth motion without lubrication but prevent lost motion under load. The top roller is mounted on an eccentric bolt shaft so clearances can be adjusted by shaft rotation. To reduce friction caused by rough spots resulting from atmospheric corrosion, parts are stored in sealed plastic envelopes until assembled.



THE TONG GRIPS SURFACES are always parallel so they can pick up thin circular sections. This improves on actual hand action in which the fingers rotate about a center. The grips are precision aluminum castings with cemented foam rubber pads. The resiliency of the pads makes them conform to contours and increases the contact area on hard objects such as glass containers. Leaf springs within the slave wrist mechanism keep the tongs normally open. Master grip pressure closes them and the ratchet unit holds them at any desired position. Stainless steel and aluminum are used throughout the unit because they have a low radioactive half-life and resist corrosion by cleaning fluids and humid atmospheres.

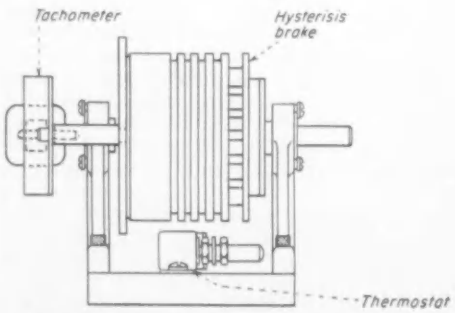




THE WESTON TACHOMETER GENERATOR has no bearings, and thus reduces maintenance requirements and lowers initial cost. Brazing the rotor to the mounting bushing avoids stressing the rotor magnets during assembly. Tachometer functions without precise rotor-stator alignment, as meter readings are dependent on frequency, not voltage. As shown in diagram of frequency responsive circuit, the generated tachometer voltage saturates a core-type transformer; the secondary emf is rectified to drive indicator.

Torque Tester Uses Hysteresis Brake

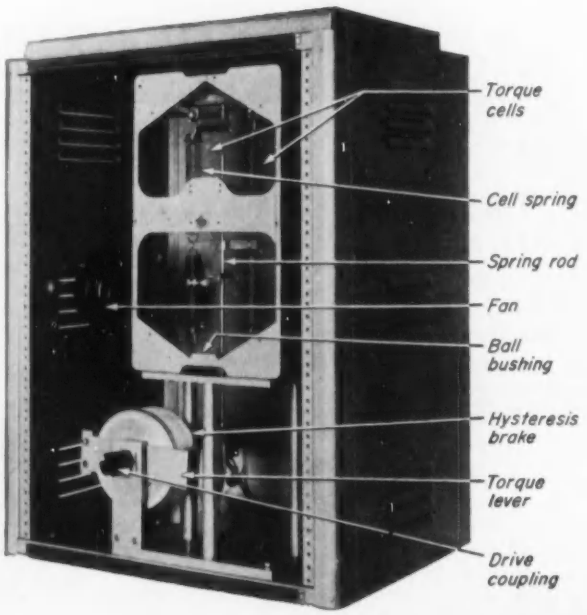
A low inertia hysteresis brake with high power absorption has been built into a torque tester for fractional hp motors by John Chatillon & Sons, Inc., New York. Special alloy springs are used in the torque cells to reduce temperature errors. The tachometer used was chosen for low initial cost and minimum maintenance.

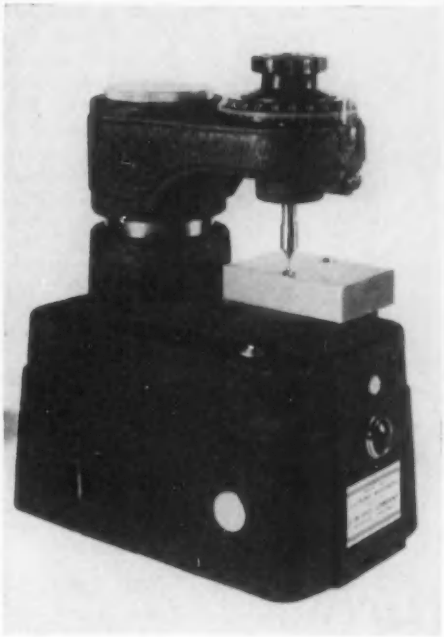


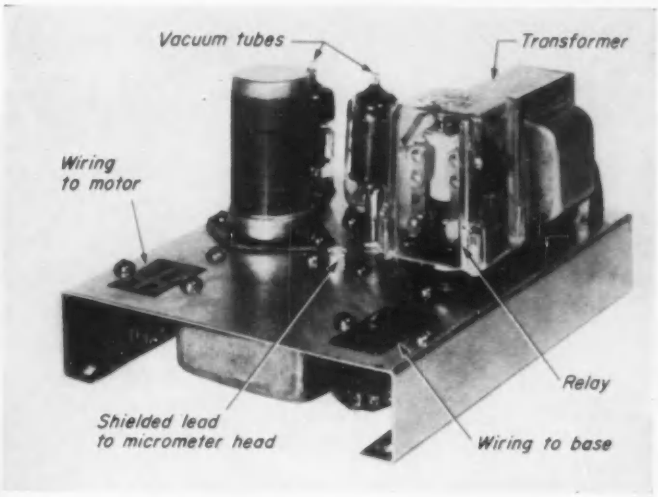
TESTER IS SHOWN with front panel removed. Magnetic braking action is controlled with manually operated variable current transformer. Power absorbing capacity is obtained by using special iron composition in the rotor; heat dissipation is limited by brake bearings.

The rod which either extends or compresses cell springs according to motor direction rides on linear ball bushings. Springs are made of a nickel-chrome alloy, manufactured by Chatillon, and reportedly maintain accuracy from zero to 145 deg F.

As shown above, the tachometer is mounted on brake rotor shaft extension; thus, torque error introduced by tachometer is compensated in scale reading.

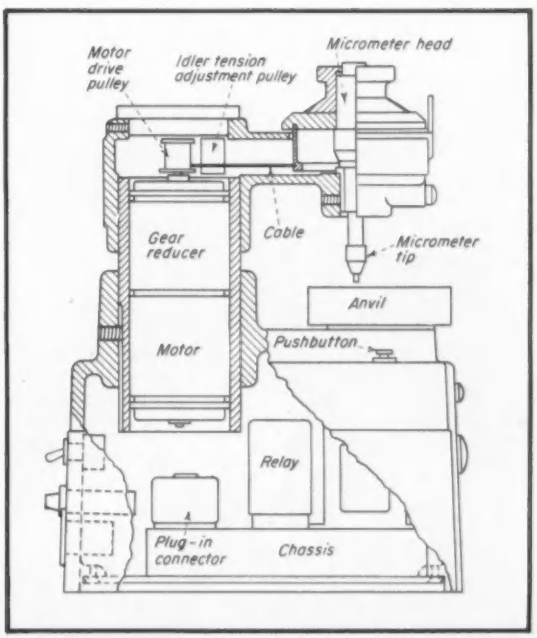






THE ELECTRONIC CIRCUIT acts as a sensitive switch to control the reversible motor with a relay. The probe is in a resistance network in the grid circuit of the first amplifier stage; probe current is made zero by setting a potentiometer in the cathode circuit to balance grid circuit potentials. The motor is stopped electrically when the relay operates. To make a measurement, operator inserts work and presses button. The unit was designed originally with the electronics in a separate cabinet, connected by cable to a manual micrometer. The instrument has been redesigned to place the controls in the base and add the motor drive.

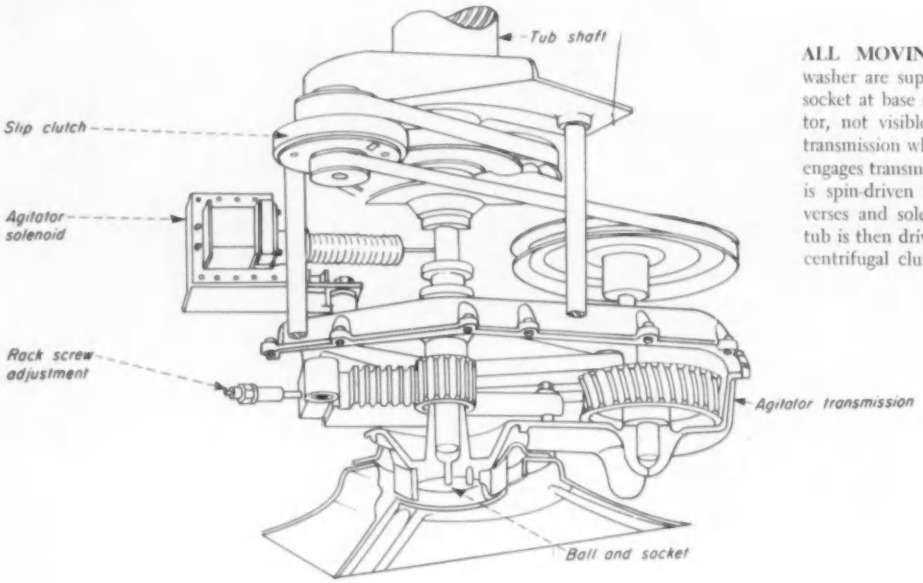
Motor Driven Micrometer



A current-less probe circuit allows this electronic micrometer to measure fragile or flexible parts with repeatability within 0.00002 in. While the motor driven head advances relatively fast the sensitive and rapid responding control system stops the probe tip before pressure is exerted on the work. Developed by Robert W. Carson of Little Falls, the unit is manufactured by the J. W. Dice Co. of Englewood, New Jersey.

SMALLER COMPONENTS have been used on the redesigned chassis to fit into the instrument base. With heat dissipation reduced to 12 watts, large radiating surface of instrument keeps the temperature rise down without recourse to forced ventilation. Placing the motor and gear reducer in the column simplifies the drive so a cord belt is used to connect the motor sheave and head pulley. All wiring is cabled and plugs into the chassis which can be removed from the bottom of the stand; the motor, column and micrometer head lift out as a unit.

Belt tension for the dial drive is set with an eccentric sheave on the column cap. Micrometer head with a 3 in. dial is built around a conventional micrometer screw and is insulated from the stand with a phenolic sleeve.

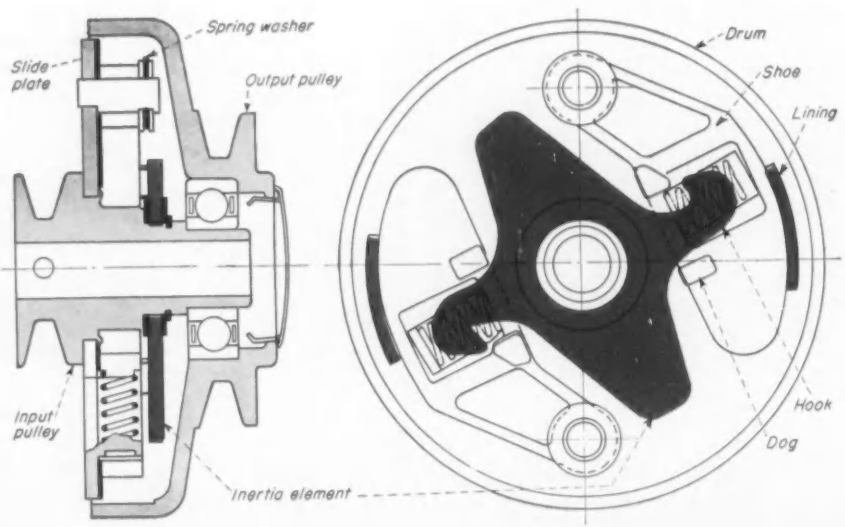


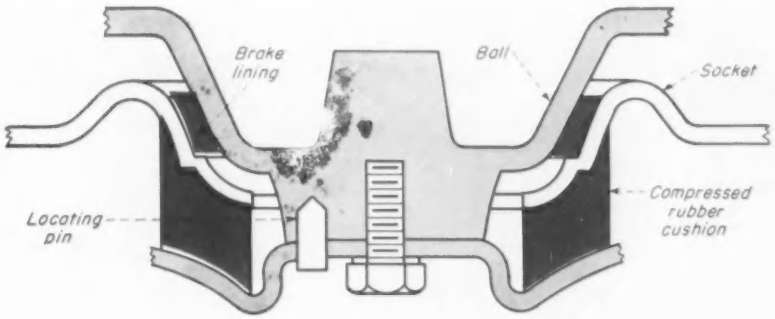
ALL MOVING PARTS of the washer are supported by a ball and socket at base of the machine. Motor, not visible, drives the agitator transmission when a solenoid clutch engages transmission and shaft. Tub is spin-driven when the motor reverses and solenoid is de-energized; tub is then driven through belts and centrifugal clutch.

Ball-Supported Washing Machine

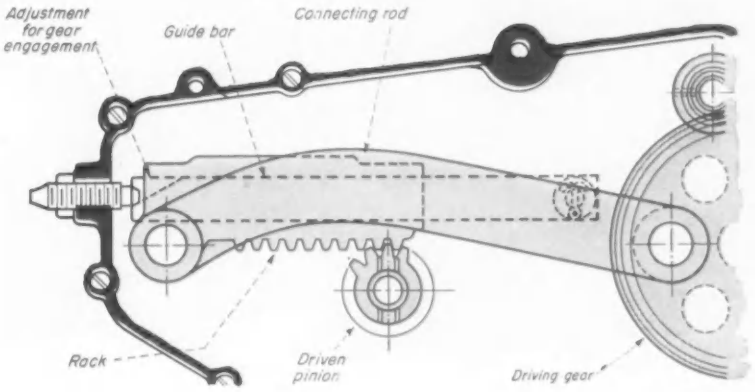
Spin speed is automatically adjusted by the unbalanced wash load at a ball-and-socket support in the Philco Automatic Washer. A uni-directional centrifugal slip clutch is used for the spin drive. Backlash between the rack and pinion of the agitator drive is removed with a screw adjustment.

THE CENTRIFUGAL SLIP CLUTCH in the spin drive limits tub acceleration and protects the motor from overload. Clutch transmits torque only during the spin cycle; during agitator cycle, inertia hooks latch the shoe dogs to prevent shoes from engaging the clutch drum.





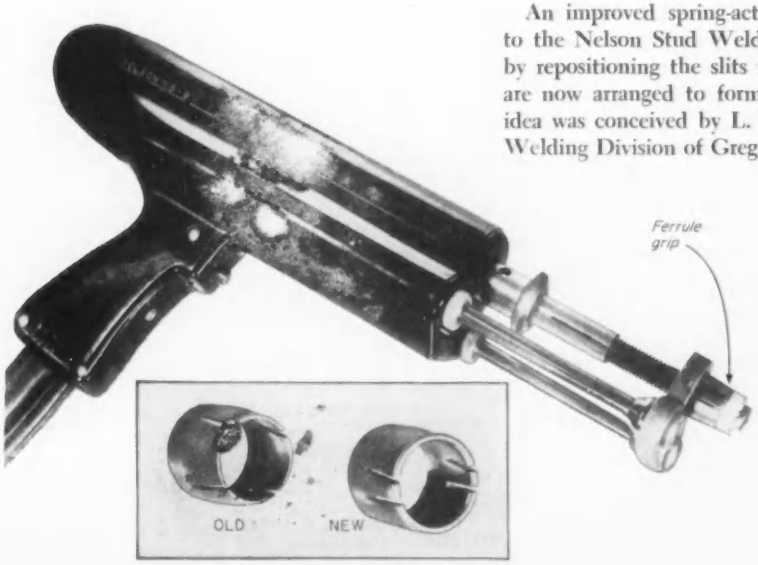
THE BALL, which is part of the crankcase, rests against the brake lining in the socket. If the washer spins off-balance, the ball presses against the lining with increased force; driving torque is then dissipated proportional to the amount of unbalance and spin speed is reduced. The ball is cushioned by a heavy rubber ring bonded to the socket.



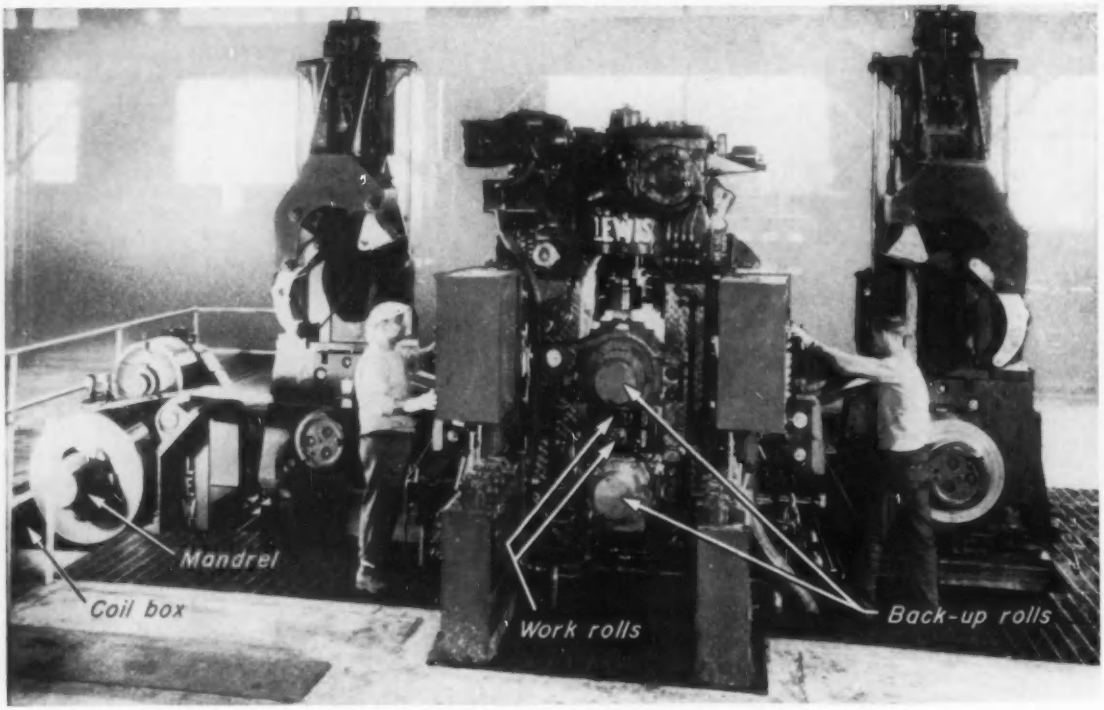
CLEARANCE between rack and pinion in the agitator transmission can be screw adjusted. The rack, which is driven by the connecting rod, slides on a stationary bar which is secured by a torsion spring and cotter pin. The screw member, when tightened, acts against a wedge on the bar to place the rack in closer mesh with the pinion.

Spring Fingers Give Positive Grip

An improved spring-action ferrule grip has been added to the Nelson Stud Welding Gun (see Feb. 1956, p. 156) by repositioning the slits in the grip collar. The four slits are now arranged to form narrow spring-like fingers. The idea was conceived by L. John Mowry of the Nelson Stud Welding Division of Gregory Industries, Lorain, Ohio.



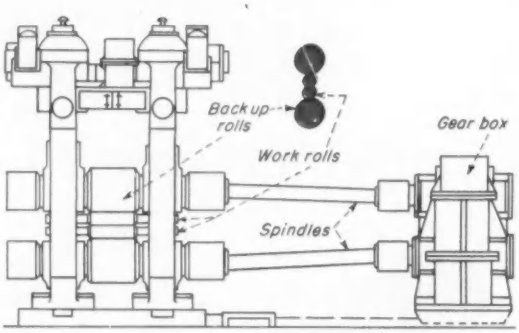
SLITS WERE RE-POSITIONED as indicated in comparison of old and new collar designs. Copper collar holds porcelain ferrules which dam molten metal during arcing cycle. With old design, ferrules slipped out or did not fit into the grip. The narrow sections now give flexible gripping action, while the broad sections give greater support when gun is pressed against the work. Use of narrow spring fingers also allows collar thickness to be increased for greater strength.

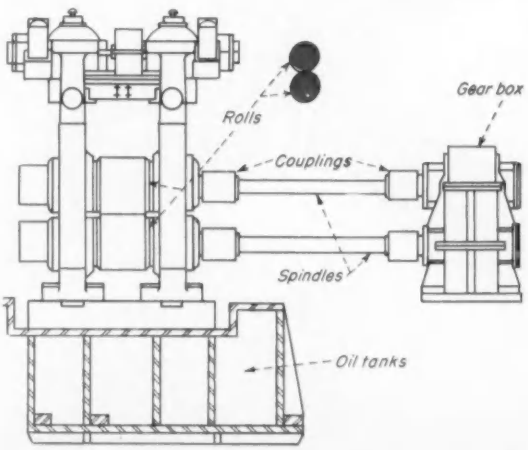


MILL IS SHOWN in the 4-high configuration for cold reducing steel strip. The strip is fed from the mandrel as shown or from a coil box below the floor at lower left. Hydraulic cylinders position the mandrel and lift the coil from the box. The unwinding rollers have been placed in the bottom of the box to reduce floor space requirements. Piping used for coolant and lubrication systems has been reduced by building sumps and pumping units into the structural steel base.

Convertible Mill

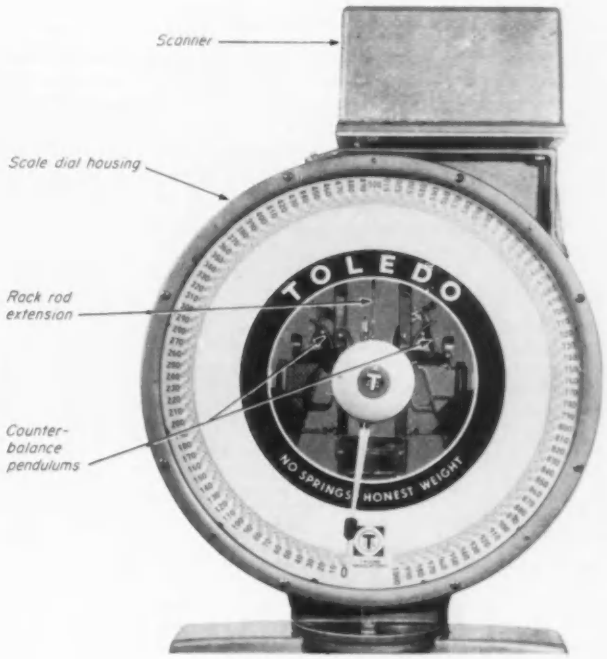
A mill which functions as either a 2-high or a 4-high unit has been designed by Blaw-Knox Co., Lewis Machinery Div., Pittsburgh. One drive is used for both operations; two work rolls are added for the 4-high set-up. Combining the coil box and unwinder as one unit and placing the coolant and lubrication systems in the machine base makes a compact design.





THE MILL IS DRIVEN by two d-c variable speed motors through speed reducers and forged steel spindles. The same bearings are used for the large power driven rolls in each arrangement to simplify the drive system. Mounting these bearings in sliding chocks and using gear type couplings makes possible the change to a 4-high configuration by adding the small work rolls. The work rolls are friction driven; direct drives are used in conventional 4-high mill.

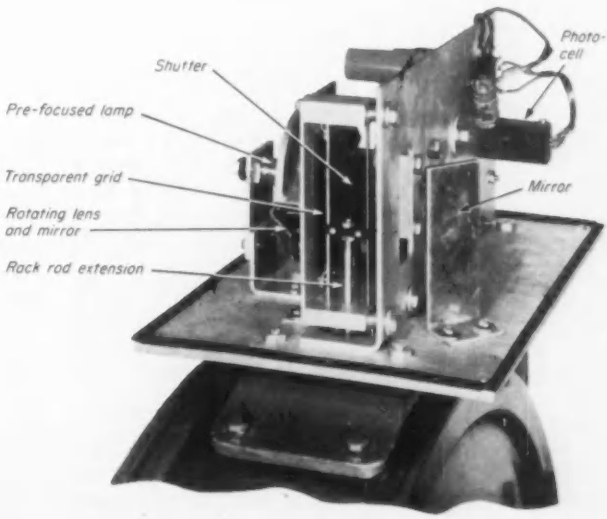
THE OUTPUT is fed to a decade counter and translator unit and then transmitted to remote tabulating card punches, tape punches, adding machines or electric typewriters. The information is delivered to the scanner as linear vertical motion of a shutter driven by an extension to the rack-rod of the double pendulum indicating mechanism. The rack-rod also drives the scale pointer. By taking the basic weight information from this point in the balance mechanism, a linear output is obtained without introducing significant friction forces. Errors from electrical drift are avoided by using a cyclic scanning system and converting the data to digital form at the scale.



Scanner Transmits Digital Weight Signal

A reciprocating shutter varies the number of grid lines exposed to a moving light beam to transmit weight data to remote indicating and recording devices. Developed by the Toledo Scale Co., Toledo, Ohio, the scanning unit is operated by the mechanism of their standard scales.

BASIC SCANNER ELEMENTS are a rotating light source, a transparent grid, a reciprocating shutter and a photocell. The grid is placed on a glass base photographically and has 1000 lines in a 2½ in. length representing full travel of the scale mechanism. Shutter position and the number of lines exposed to the cyclic light beam are directly proportional to the weight measured. A prefocused lamp at the center of a motor driven disk with two 45 deg mirror elements and projection lenses forms a rotating light source which scans the grid 120 times per minute. As each grid line has a definite weight value, the light pulses produce electrical signals at the photocell proportional to scale indication.



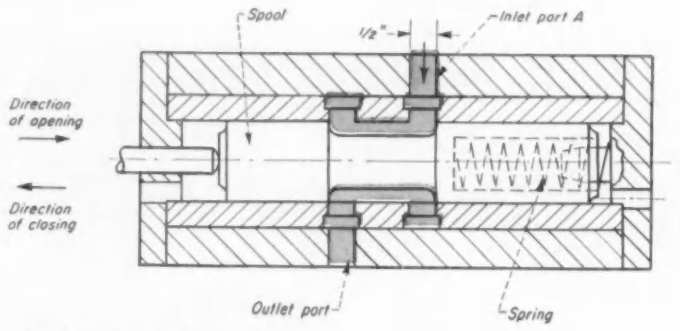


Fig. 1 Above — Time required to close inlet port of a hydraulic shut-off valve depends upon the mass of spool, frictional resistance of spool and spring constant.

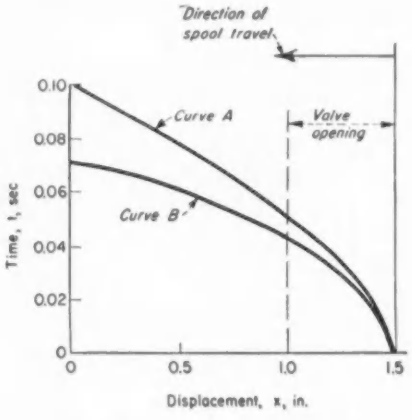


Fig. 2 Right—Time-displacement curves of the spool in Fig. 1. Curve *A* is for spool with frictional resistance proportional to velocity (as assumed for hydraulic valves); curve *B* is for spool with constant frictional resistance (as assumed for pneumatic valves).

Calculating Time Lag of Hydraulic and Pneumatic Valves

Formulas and curves for calculating the operating time required by springs and solenoids to open or close valves; method for determining frictional resistance of valve spools; design suggestions for increasing the speed of operation.

LOUIS DODGE, Cincinnati, Ohio

THE DESIGN OF COMPLEX MACHINES powered by a hydraulic or pneumatic system requires precise coordination and timing of individual machine elements. Usually a time-table of events is constructed and it is necessary to know the time lag for opening or closing the control valves.

Spring-Actuated Hydraulic Valves

A hydraulic shut-off valve of the type shown in Fig. 1 may be opened manually (usually for a short duration) or by a solenoid or cam. Its closing stroke, however, is spring actuated. The time required to close port A is a function of the spring constant c, the mass of the spool m and the frictional resistance (damping force) d. When good lubrication of the moving spool is assured, as in hydraulic valves, it can be assumed that the damping force is proportional to the velocity of the spool. In pneumatic valves, which have little or no lubrication, the damping force is essentially constant. This assumption also applies to slowly accelerated valves.

When damping force is proportional to the velocity, the equation of motion of the spool is:

$$mx'' + d_v x' + cx = 0 \qquad (1)$$

where mx'' is the force resulting from the acceleration of the mass; $d_v x'$ is the damping force proportional to the velocity x' of the mass; and cx is the spring force, proportional to displacement.

Eq (1) is a linear and homogeneous differential equation of the second degree. Its solution will be in the form of e^{nt} and can be obtained by substituting n^2 for x'', n for x', dividing by m and substituting the values:

$$\frac{c}{m} = \omega^2, \qquad \frac{d_v}{m} = 2p$$

Eq (1) can then be rewritten in the form of

$$n^2 + 2pn + \omega^2 = 0 \qquad (2)$$

of which the roots are

$$n_{1,2} = -p \pm \sqrt{p^2 - \omega^2} \qquad (3)$$

General solution of Eq (1) is

$$x = \sum A_n e^{nt} \qquad (4)$$

for all roots of Eq (2).

The physical nature of the solution depends on the nature of the roots. When the damping effect is weak the plunger will oscillate if attached to the spring, signifying that $\omega > p$. The radical in Eq (3) is then negative with imaginary roots. When the damping effect is strong or the spring weak ($\omega < p$) a creeping motion ensues and the radical is positive with real roots. The latter case may be disregarded for practical reasons, since a sluggish valve is undesirable.

Substituting $i\phi$ for $\sqrt{p^2 - \omega^2}$, Eq (4) becomes

$$x = e^{-pt}(A_1 e^{-i\phi t} + A_2 e^{+i\phi t}) \qquad (5)$$

Using De Moivre's theorem that

$$e^{-i\phi t} = \cos \phi t + i \sin \phi t$$

Eq (5) becomes

$$x = e^{-pt}(C_1 \cos \phi t + C_2 \sin \phi t) \quad (6)$$

To determine the arbitrary constants, the initial conditions are considered. When $t = 0$, then $x = x_o$ and $x' = 0$, and

$$x = e^{-pt}(x_o \cos \phi t) \quad (7)$$

The period of vibratory motion for one cycle is

$$T = \frac{2\pi}{\phi} = \frac{2\pi}{\sqrt{\omega^2 - p^2}} \quad (8)$$

Practical value of above equations depends on the correct evaluation of d_v, the coefficient of damping. One way to determine this value is to attach the spring firmly to the spool, keep all other conditions the same and apply an initial force to the spool. The number of oscillations in a given interval of time is then counted and the reduction in amplitude noted. The amplitudes of the oscillations diminish in a geometric progression which can be expressed by the equation:

$$D = \ln \frac{X_o}{X_1} \quad (9)$$

The term D is called the logarithmic decrement of the amplitude.

Sample calculations: Assume that a spool with $m = 0.01$ lb sec²/in. undergoes five oscillations, or 10 half periods, in 2 sec with 80 per cent reduction in amplitude. Then

$$D = \ln \frac{X_o}{X_1} = \frac{\ln 5 - \ln 1}{10} = \frac{1.6094}{10} = 0.161$$

Period of oscillation is

$$T_1 = \frac{2}{5} = 0.4 \text{ sec}$$

and the frequency of oscillation is

$$\omega = \frac{2\pi}{T_1} = \frac{2\pi}{0.4} = 15.7 \text{ rad/sec}$$

For small decrements $d_v = 2mp$, and $p = D\omega/\pi$. Therefore

$$d_v = \frac{2m\,D\omega}{\pi} = \frac{2(0.01)(0.161)(15.7)}{3.14}$$

$$d_v = 0.0161 \text{ lb-sec/in.}$$

Time-displacement characteristics of the valve can now be determined. The constants for Eq (7) are:

$$c = m\omega^2 = (0.01)(15.7)^2 = 2.47 \text{ lb/in.}$$

$$p = \frac{d_v}{2m} = \frac{0.0161}{2(0.01)} = 0.805 \text{ rads/sec}$$

$$\phi = \sqrt{\omega^2 - p^2} = \sqrt{15.7^2 - 0.805^2} = 15.7$$

Maximum compression of the spring is to be $x_o = 1.5$ in. with the port open as shown in Fig. 1. Only the first quarter of the full period is of interest; therefore, Eq (7) is evaluated from $t = 0$ to $t = T/4 = 0.1$ sec. As an example, for $t = 0.01$, Eq (7) becomes:

$$x = 2.72^{-(0.008)}(1.5) \cos (0.157) = 1.47$$

The time-displacement curve of Eq (7) is shown as curve A in Fig. 2. Closing of the ½ in. wide port A takes 0.05 sec, not including a small overlap needed in practice.

SYMBOLS

A, B, C, l, n, p, r	constants as defined by their respective equations
a	dimension, in.
c	spring constant, lb/in.
d_c	coefficient of damping (constant), lb-sec/in.
d_v	coefficient of damping (varies with velocity), lb-sec/in.
D	logarithmic decrement of amplitude
e	natural logarithmic base, 2.72
i	square root of minus one
m	mass of spool, lb-sec²/in.
P	force, lb
t	time, sec
T	period of oscillation, sec
x	displacement of spool, in.
x_0	initial position of spool
x'	velocity of spool, dx/dt
x''	acceleration of spool, d^2x/dt^2
X_0	initial amplitude, in.
X_1	amplitude at some position of time
ϕ	frequency factor
ω	frequency of oscillation, cycles/sec

Because of an increase in velocity, a ½ in. wide port opening at the end of the stroke needs only 0.022 sec to close.

Spring-Actuated Pneumatic Valves

Since pneumatic valves have little or no lubrication on the spool the damping force d_c can be considered as constant. The differential equation of motion can then be written in the form:

$$mx'' + d_c x' + cx = 0 \quad (10)$$

Dividing by m and using the notations

$$\frac{c}{m} = \omega^2, \quad \frac{d_c}{m} = a\omega^2,$$

Eq (10) becomes:

$$x'' + \omega^2(x + ax') = 0 \quad (11)$$

Constant a can be found by measuring the difference between the actual free length of the spring and the compressed length resulting from the frictional resistance of the spool.

The solution to Eq (11) is

$$x = a + (x_o - a) \cos \omega t \quad (12)$$

Eq (12) defines the motion of a spool with dry friction for the first half period only. If the frictional resistance is negligible then Eq (12) can be simplified to:

$$x = x_o \cos \omega t \quad (13)$$

Sample Calculations: Let $x_o = 1.5$ in., $a = 0.4$ in. $c = 5$ lb/in., $m = 0.01$ lb sec²/in. Then $\omega = 22.36$ rads/sec, and $T = 0.28$ sec. At the end of the first quarter period $t = T/4 = 0.07$ sec; therefore Eq (12) is evaluated between $t = 0$ and $t = 0.07$. For $t = 0.01$, x is equal to

$$x = 0.4 + (1.5 - 0.4) \cos (0.223) = 1.47$$

Time-displacement curve of Eq (12) is plotted as curve B in Fig. 2; closing of part A takes 0.042 seconds.

Solenoid-Operated Valves

Discussion above was limited to spring-actuated strokes. For solenoid-operated valves, either the actuating stroke

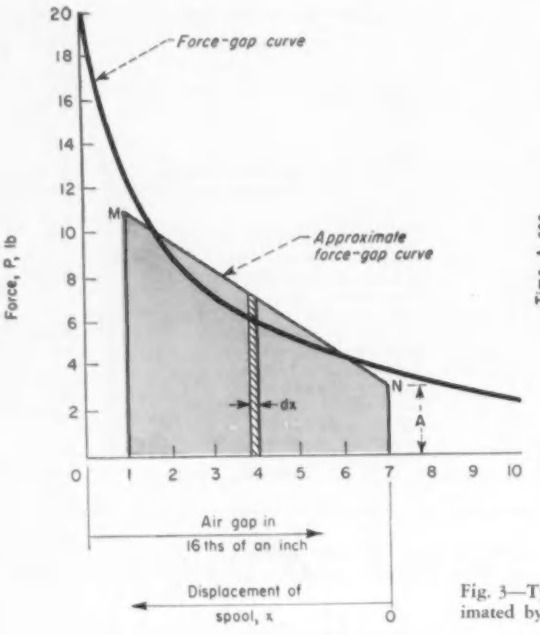


Fig. 3—Typical force-gap curve of a solenoid. Curve can be approximated by line *MN* to simplify time-displacement calculations.

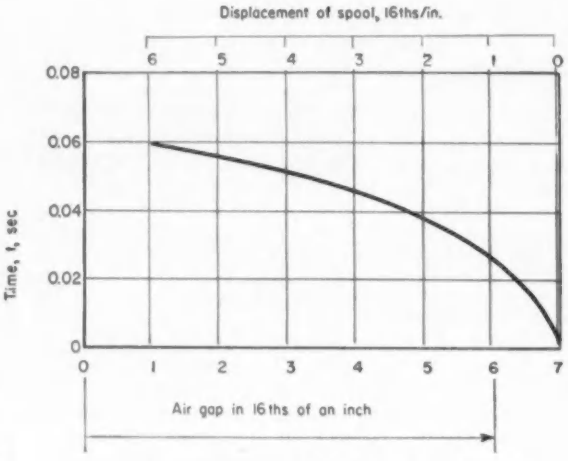


Fig. 4—Time-displacement curve of a valve spool operated by a solenoid.

is operated by the solenoid and the return stroke by a spring, or a dual solenoid is used (usually one on each side of the valve) with both strokes solenoid-operated. In either case a simplified but sufficiently accurate approach can be developed to calculate the time necessary to open or close the ports with a solenoid.

The force-gap curve of the solenoid, can easily be determined from actual tests. A typical curve is shown in Fig. 3. Assuming that only an air-gap of $\frac{7}{16}$ in. is utilized and $\frac{3}{8}$ in. spool travel is required to close a port, then the force-displacement curve can be approximated by a straight line *MN*, and the effective work represented by the area under the curve.

The differential equation of the rectilinear motion of a particle, disregarding friction, is

$$m \frac{dx'}{dt} = P \tag{14}$$

Line *MN* can be represented by the equation $P = A + Bx$, where x is measured from the $\frac{7}{16}$ in. mark. Multiplying both sides of Eq (14) by $2dx$ gives

$$2m \frac{dx}{dt} dx' = 2A\, dx + 2Bx dx$$

Integrating

$$m(x')^2 = 2Ax + Bx^2 + C_1 \tag{15}$$

When $x = 0$ and $x' = 0$, then $C_1 = 0$, and

$$x' = \frac{dx}{dt} = \sqrt{\frac{2Ax + Bx^2}{m}} \tag{16}$$

or

$$dt = \frac{dx}{\sqrt{\frac{B}{m}(2rx + x^2)}} \tag{17}$$

where $r = A/B$

Integrating Eq (17) results in

$$t = \sqrt{m/B} \ln [x + r + \sqrt{2rx + x^2}] + C_2 \tag{18}$$

When $t = 0$ and $x = 0$ then

$$C_2 = -\sqrt{m/B} \ln r$$

Therefore

$$t = \sqrt{m/B} \ln \left[\frac{x + r + \sqrt{2rx + x^2}}{r} \right] \tag{19}$$

As an example, Fig. 4 shows the time-displacement curve of Eq (19) for values of $m = 0.02$ lb sec²/in., $A = 3$ lb and $B = 21.33$ lb/in.

Design Suggestions

When fast action is demanded of a valve, the following design suggestions may be helpful:

(1)—Reduce frictional resistance by permitting a slight leakage of oil around the spool. Lap to loose fit.

(2)—Keep weight of spool to a minimum. One possibility is using a light metal such as aluminum with a hard coating to increase wear resistance, giving consideration to dissimilar expansion coefficients.

(3)—Use an annular groove with large port openings to get greater discharge area with minimum spool travel.

(4)—Use compression springs rather than solenoids for the actuating force. Solenoids are subject to greater variations in performance than springs.

(5)—Select a spring constant with a high force-deflection ratio. Make the total permissible compression of spring greater than the spool travel.

(6)—Use a small air gap on solenoids. To increase stroke use simple lever pivoted at a one-to-three ratio between solenoid and valve.

How to design single-arm balancing networks for multiple common strain-gage circuits so zero-strain reading is same for all; how to apply to bridges on hand or in design of new ones.

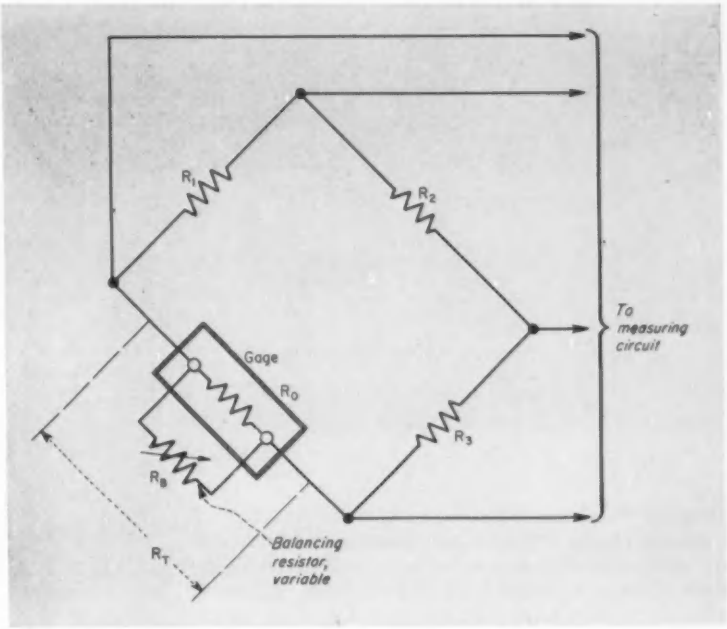


Fig. 1—Basic circuit used to adjust zero-strain reading of several gages so that they all show same zero reading when successively connected to measuring instrument. R_0 is only strain gage shown, but R_1, R_2, R_3 may or may not be gages. Balance point of bridge is adjusted by varying value of balancing resistor R_B.

Strain Gage Balancing

. . . *Simplifies Multiple-Bridge Measurements*

PETER K. STEIN
Instructor, Mechanical Engineering
Massachusetts Institute of Technology

RESISTANCE STRAIN GAGES from the same production run and package, nominally of the same resistance, and mounted by the same person vary slightly in initial resistance after installation. This variation is due to manufacturing tolerances and slight differences in mounting. For this reason bridges composed of like gages usually show varying amounts of initial unbalance which complicate measurements. To simplify and speed up measuring process, associated strain-gage circuits can be brought to a common-zero reading on one measuring instrument by use of common-zero balancing techniques. This provides initial balancing of several circuits so they all show the same zero-strain reading when successively measured.

Three principal common-zero balancing methods are: (1) resistance of single arm of bridge is varied, (2) resistance of two adjacent arms is simultaneously varied, and (3) reference-bridge element values are varied to bring combined outputs of reference and transducer bridges to desired value. This article describes only the single-arm method such as used in Baldwin switching and balancing units. Use of this method requires that connections to the individual bridge arms be available.

The most common basic type of strain gage circuit used for initial zero balancing of a number of circuits is shown in Fig. 1. Strain gage R_o and balancing resistor R_B form zero-balancing portion of the circuit; zero-strain reading is adjusted to desired value by varying R_B. Each strain-gage bridge to be balanced incorporates a similar zero-balancing network.

Design of a zero-balancing circuit is based on several factors. First, the resistance of the zero-balancing circuit, including strain gage, must be variable over a range of at least equal to maximum initial bridge unbalance. This unbalance is equal to $2R_o\,MN/100$, where R_o is nominal gage resistance, M is per cent tolerance of gage resistance, and N is number of gages in the bridge. In terms of absolute values this can be written:

$$\frac{1}{2}\left[R_T\Big|_{R_{B-MIN}} - R_T\Big|_{R_{B-MAX}}\right] = \frac{R_O\,MN}{100} \qquad (1)$$

where $R_T|_{R_B-MIN}$ means the value of R_T when R_B is a mini-

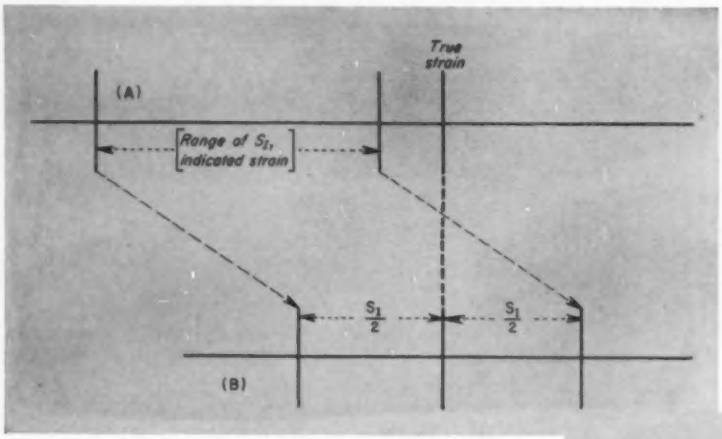


Fig. 2—(A) When using manufacturer's recommended gage factor for S_I in Fig. 1, indicated strain is always less than true strain and range in which indicated strain can fall is determined by minimum and maximum values of R_B required to bring bridge to common zero. (B) Multiplying manufacturer's gage factor by correction factor F_A, derived in text, and using this value in measurements centers range of possible indicated strain about true strain reading.

mum, and $R_T|_{R_B=MAX}$ means the value of R_T when R_B is a maximum. In Fig. 1 the minimum value of R_B can be zero or a short circuit, but in practice is limited to some higher value. Since it is equally likely to find bridge unbalances when R_B is a maximum and when R_B is a minimum, midpoint of this balance range should correspond to nominal gage resistance R_o or:

$$\frac{1}{2}\left[R_T\Big|_{R_{B-MIN}} + R_T\Big|_{R_{B-MAX}}\right] = R_O \qquad (2)$$

Because R_B is connected in parallel with gage R_o, a given strain-induced resistance change ΔR_o in R_o, causes the ratio $\Delta R_o/R_o$ to always be greater than the ratio of change in balancing network resistance, ΔR_T to R_T, or:

$$\frac{\Delta R_O}{R_O} > \frac{\Delta R_T}{R_T}. \qquad (3)$$

This means that net per cent resistance change of R_T caused by strain is smaller than that of gage R_o alone; and when using the manufacturer's recommended gage factor $(GF)_m$ for gage R_o, an instrument calibrated to read in strain will read lower than true strain S_T as shown in Fig. 2(A). In order to convert indicated reading S_I to true strain S_T, indicated strain must be multiplied by a factor of $1/F$, or:

$$S_T = S_I\left(\frac{1}{F}\right) \qquad (4)$$

where

$$F = \frac{\left(\frac{\Delta R_T}{R_T}\right)}{\frac{\Delta R_O}{R_O}} \qquad (5)$$

The value of F to be applied to strain readings of R_o depends on the value of R_B required to bring that bridge to the common zero reading. Different bridges in a system have different zero-strain indications and values of R_B after common-zero balancing has been achieved; and each bridge in the system has a different correction factor F for the gage in the balancing arm.

The average correction factor F_A for gage R_o may be defined as:

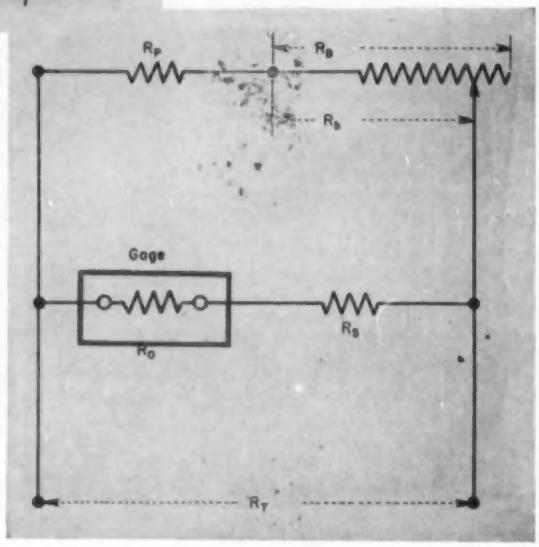


Fig. 3—Zero-balancing circuit commonly used. Minimum value of balancing resistance is equal to value of R_P; maximum value is sum of R_P and R_B. R_S is used to make value of R_T greater than R_O if required.

$$F_A = \frac{1}{2}\left[\frac{\left(\frac{\Delta R_T}{R_T}\right)_{R_{B-MIN}} + \left(\frac{\Delta R_T}{R_T}\right)_{R_{B-MAX}}}{\Delta R_O/R_O}\right] \qquad (6)$$

and the maximum change in F_A due to probable variation of R_B from its midpoint value is given by:

$$\Delta F_A = \frac{1}{2}\left[\frac{\left(\frac{\Delta R_T}{R_T}\right)_{R_{B-MIN}} - \left(\frac{\Delta R_T}{R_T}\right)_{R_{B-MAX}}}{\Delta R_O/R_O}\right] \qquad (7)$$

Average correction factor F_A is used to obtain corrected gage factor $(GF)_a$ which in turn is used to adjust the dials of the measuring devices so that a true strain reading is indicated. The corrected gage factor is the product of manufacturer's gage factor and average correction, or:

$$(GF)_a = (GF)_m\,(F_A) \qquad (8)$$

Using corrected gage factor $(GF)_a$ for gage R_o moves the true-strain reading in the center of range of maximum possible deviation caused by different values of R_B required

to zero-balance various bridges is shown in Fig. 2(B). Using correction factor F_A, the subsequent error introduced by the balancing circuit will not be more than $\Delta F/F_A$ (in per cent if multiplied by 100).

Balancing-Circuit Design Factors

To determine characteristics of a given zero-balancing circuit, or to design a circuit to fit given characteristics, nominal gage resistance for which circuit is designed R_o, manufacturer's gage tolerance M, and number of gages N used in bridge are important. In addition, the following must be known or specified.

Maximum balance-circuit resistance, including gage R_o:

$$(R_T)_{MAX} = R_O(1 + MN) \tag{9}$$

Minimum balance-circuit resistance, including gage R_o:

$$(R_T)_{MIN} = R_O(1 - MN) \tag{10}$$

Maximum error expected from gage in balance arm:

$$F_{MAX} = F_A + \Delta F \tag{11}$$

Minimum error expected from gage in balance arm:

$$F_{MIN} = F_A - \Delta F \tag{12}$$

Determining Circuit Characteristics

A zero-balancing circuit commonly used is shown in Fig. 3. Here, resistor R_s is connected in series with gage R_o to adjust strain gage sensitivity; R_P is connected in series with R_B to establish desired minimum value of that branch and consequently of R_T. In Fig. 3 R_b is that part of R_B which is in the circuit for any given position of the slide wire.

If resistances of individual elements of this circuit are known, the values of R_o, M, N, F_A and ΔF may be determined using Eqs. (13) through (18) and general relationships previously established.

$$R_T = \frac{(R_O + R_S)(R_P + R_b)}{R_O + R_S + R_P + R_b} \tag{13}$$

$$\frac{\Delta R_T}{R_T} = \frac{\Delta R_O}{R_O}\left[\frac{R_O(R_P + R_b)}{(R_O + R_S)(R_O + R_S + R_P + R_b)}\right] \tag{14}$$

$$(R_T)_{MAX} = R_O(1 + MN) = \frac{(R_O + R_S)(R_P + R_B)}{R_O + R_S + R_P + R_B} \tag{15}$$

$$(R_T)_{MIN} = R_O(1 - MN) = \frac{(R_O + R_S)R_P}{R_O + R_S + R_P} \tag{16}$$

$$(F)_{MAX} = F_A + \Delta F = \frac{R_O(R_P + R_B)}{(R_O + R_S)(R_O + R_S + R_P + R_B)} \tag{17}$$

$$(F)_{MIN} = F_A - \Delta F = \frac{R_O R_P}{(R_O + R_S)(R_O + R_S + R_P)} \tag{18}$$

Designing Circuit to Given Characteristics

It is assumed that the circuit in Fig. 3 has been selected as the basis for design calculations. R_o is known, but Eqs (15), (16), (17), and (18) need to be solved for R_P, R_B, and R_B. Since there are four equations and three unknowns, M, N, F_A and ΔF cannot be specified arbitrarily because a relationship between them must be satisfied in order for a solution to exist. This relationship is satisfied by the following equations:

$$\frac{R_O(1 + MN)}{F_A + \Delta F} = \frac{(R_O + R_S)^2}{R_O} = \frac{R_O(1 - MN)}{F_A - \Delta F} \tag{19}$$

To obtain the relationship between M, N, F_A and ΔF, the equations in (19) are solved to give:

$$MN = \frac{\Delta F}{F_A} \tag{20}$$

And the solution for R_s is obtained from:

$$\frac{R_S}{R_O} = -1 \pm \frac{1}{\sqrt{F_A}} \tag{21}$$

But R_s must be positive, therefore $1 > F_A > 0$, hence indicated strain from common-zero balancing circuit is always less than true strain and use of a correction factor is necessary.

To obtain R_P the solution for R_s is inserted in Eq (18) giving:

$$\frac{R_P}{R_O} = \frac{1 - MN}{1 - [\sqrt{F_A}(1 - MN)]} \tag{22}$$

For a real solution, R_P must assume only positive values, which implies that:

$$F_A < \frac{1}{(1 + MN)^2} \tag{23}$$

As a result the correction factor is always less than unity and can never assume values in excess of those specified by Eq (23) for given values of M and N.

A solution for R_B is now possible using Eq (24):

$$\frac{R_B}{R_O} = \frac{(1 - MN)\left(\frac{1}{F_A}\right)}{\left(\frac{1}{\sqrt{F_A}} - 1 - MN\right)\left(\frac{1}{\sqrt{F_A}} - 1 + MN\right)} = \frac{(1 - MN)}{1 - F_A(1 + M^2N^2)} \tag{24}$$

and

$$\left(F_A\right)_{MAX} = \frac{1}{(1 + MN)^2} \tag{25}$$

To simplify determination of values for resistance in the sample circuit of Fig. 3, the following procedure should be used.

1. The quantities M and N are known, from which a maximum correction factor $(F_A)_{MAX}$ can be obtained using Eq (25).
2. Correction factor F_A is selected arbitrarily at some value below maximum determined from Eq (25).
3. Values of R_s/R_o, R_P/R_o, R_b/R_o, $\Delta F/F_A$ are calculated from specified values of M, N, and F_A.
4. Since nominal gage resistance R_o is known, values for R_s, R_P, R_B, can be readily obtained.

Design Example:

Given: $M = 0.01$
$N = 2$
$R_O = 120$ ohms

Then from Eq (20): $\Delta F/F_A = 0.02$

And from Eq (25): $(F_A)_{MAX} = 0.96$

Let F_A be 0.81 (arbitrarily selected to be less than 0.96), then

from Eq (21) $R_s/R_o = 0.111$

from Eq (22) $R_P/R_o = 8.25$

and from Eq (24) $R_B/R_o = 4.15$

In the example cited, use of a gage factor corrected by F_A results in an error known to be less than 2 per cent at any point on the balancing potentiometer. Had this correction factor not been used, the error would have been between 2 and 6 per cent, and with an unknown amount of error between these limits.

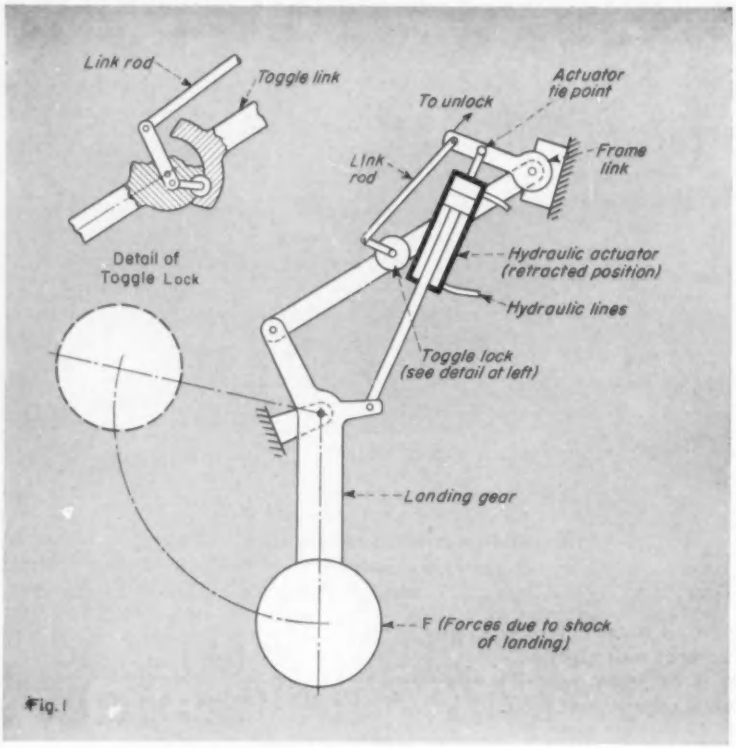


Fig. 1—Hydraulic actuator using an external linkage system in an aircraft landing gear to keep its piston rod locked in extreme positions. Main disadvantages are bulkiness and complexity.

Locking Mechanisms for Hydraulic Actuators

FIVE METHODS—four mechanical and one hydraulic—for locking the piston of a hydraulic cylinder under load; advantages and limitations of each; relationship between load capacity and cylinder diameter.

R. A. CHACE
Research Engineer, Boeing Airplane Co.

FOR YEARS, BETTER METHODS have been needed for locking hydraulically actuated mechanisms in desired positions. The aircraft industry, for example, has been faced with the problem of keeping landing gears and bomb doors retracted. Positive locking of hydraulic pistons is also desirable in: machine tools; construction and farm equipment; control systems of nuclear reactors; erection systems of guided missiles.

External linkage systems based on the toggle principle, Fig. 1, have been used on aircraft landing gears subjected to impact loads. The hydraulic actuator is kept locked in its retracted position by the toggle links lying in a straight line—in other words, the links are in "toggle". This prevents a force such as F from inadvertently extending the actuator.

To unlock, hydraulic pressure extends the actuator which rotates the frame-link clockwise. This, in turn, pulls the lock rod, thus unlocking the toggles and "breaking" them off center. Continued extension of the actuator now rotates the landing gear. During this cycle, the frame-link continues to rotate so that the actuator tie point passes dead center. Final extension straightens the toggles which automatically lock by spring pressure. To drop the landing gear the cycle is reversed.

Such external linkages, however, are heavy and bulky; the complicated assemblies are expensive and susceptible to failure during operation.

Hydraulic control systems, Fig. 2, are commonly used to lock an actuator in any position. By using an intermediate position on the control valve, fluid is trapped on both sides of the piston thus preventing movement. However, leakage, or compressibility of the oil allows the piston to settle under load. Also, if wide temperatures are encountered, a thermal relief valve must be used to prevent bursting the actuator during thermal expansion of the oil, and make-up fluid must be supplied during thermal contraction.

Pin-lock mechanisms, Fig. 3, use fluid pressure to force a locking pin to withdraw from a groove in the piston and, at the same time, drive the piston. At the end of the piston travel, the lock pin is forced into the groove by a spring. Disadvantage of this method is that the pin, as it is withdrawing, has less contact area to support the piston load (both hydraulic and external). Soon, one small edge has to take the whole load and failure may occur from over stressing. Although it is possible to sequence fluid pressure to operate the lock pin first and thus eliminate the pressure load of the piston, high external loads may still damage the pin. Also a

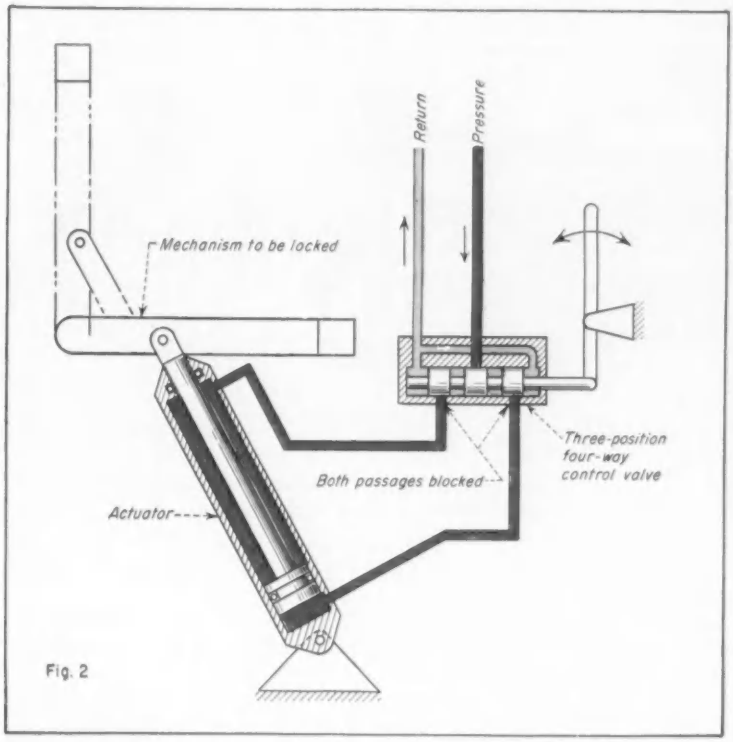


Fig. 2—Using a neutral position on a four-way valve to lock a hydraulic piston. Although this permits locking in intermediate positions, the piston tends to creep.

pressure surge may prematurely unlock the actuator.

Ball-lock mechanisms, Fig. 4, are more precise in operation than the pin-lock type. Fluid entering port A, drives the piston to the right and exerts pressure on the piston rod. As soon as the piston moves far enough to uncover the locking balls, the balls are cammed out of the groove in the rod by motion of the rod. The rod is now free to move. At the end of its stroke, the right-hand piston contacts the locking balls and is forced to the left against the spring. The groove in the piston rod then slides under the locking balls which are forced into the groove and trapped. This again locks the piston rod.

Limitation of this system is the small number and diameter of balls that can be used to take the bearing loads. Also, system is not pressure balanced against hydraulic surges.

Toggle-Lock Actuator

A recent development of Boeing is the internal "toggle-lock" mechanism shown in Fig. 5, which contains a hydraulically operated mechanical lock. It can be locked either fully retracted or extended and unlocked under high external loads.

The actuator shown in the retracted position, is kept locked by the right

Fig. 3 right—Internal pin-lock mechanism operated by the same hydraulic pressure that drives the piston. Fluid enters from port *A*. Simple and positive but subjected to high wear.

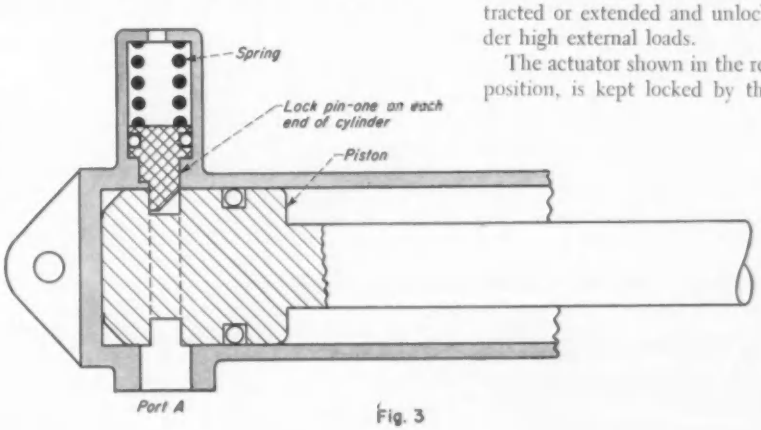


Fig. 3

Fig. 4 below—Hydraulically operated ball-lock mechanism. Less wear than pin-lock type but restricted to applications with smaller external loads.

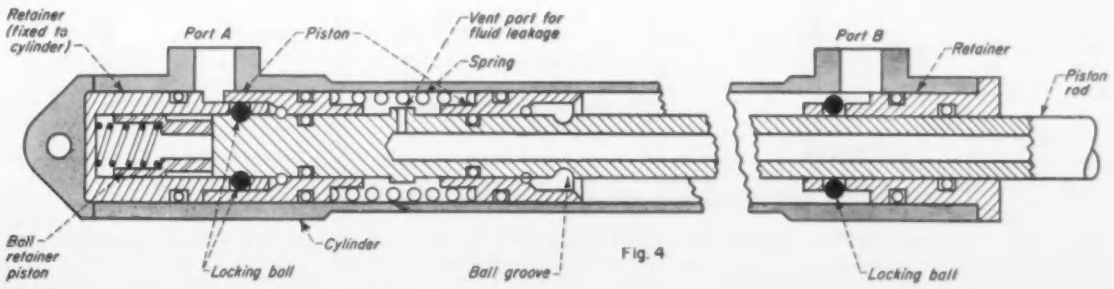


Fig. 4

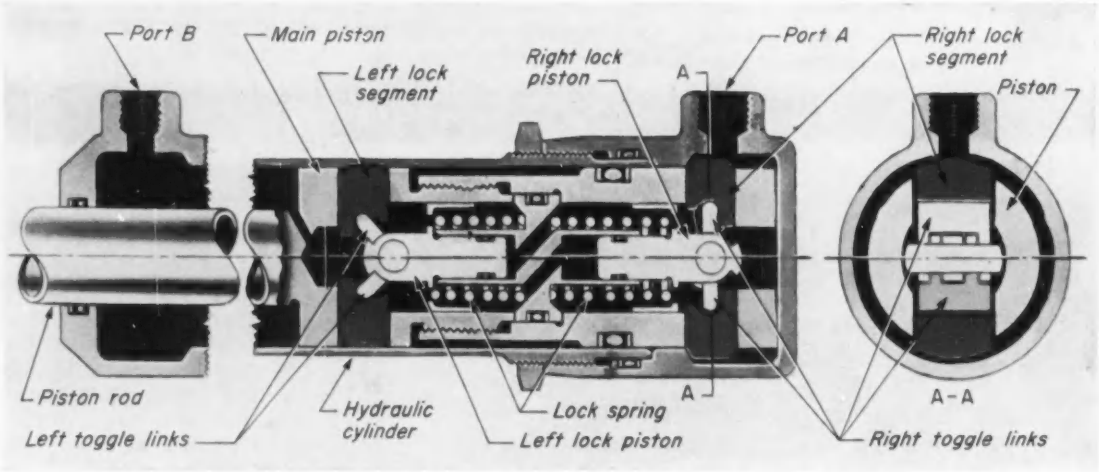


Fig. 5—Internal toggle-lock mechanism made by Tog-Loc Inc., Bellevue, Wash. Toggle links keep lock segments engaged in locked position. Segments are mechanically withdrawn as pressure drives piston.

lock segments. Hydraulic pressure, sent through port A to drive the main piston, also acts on the right lock piston moving it toward the rod end. This pulls the right toggle links off center which release the lock segments. The segments are then cammed inward as the whole assembly is driven toward the left by hydraulic pressure acting on the main piston. When the piston rod is fully extended, the lock spring and hydraulic pressure act on the left lock piston. This, in turn, extends the left toggle links and lock segments, thus locking the actuator in the extended position. Load capacity of the lock varies with actuator diameter; maximum operating load for a 4 in. dia is 100,000 lb.

For automatic sequencing, the locking segments can be designed to actuate a sequence valve or an electric switch at the end positions. Fig. 6 illustrates typical sequencing circuit for two actuators working in parallel.

Some of the advantages of this type of locking mechanism are:

1. Pressure balanced against hydraulic surges.
2. Load carrying ability high in locked positions.
3. Can be adapted for mechanical or electrical sequencing, or pneumatic operation.
4. Not affected by vibration.
5. Not dependent upon hydraulic pressure to remain locked.
6. Can be designed to stay locked when overloaded.

One of the characteristics of this design is that the lock spring and the hydraulic pressure keep the segments out against the hydraulic cylinder during travel of the piston. This sliding action may cause the segments to gall. However, segments made from aluminum-nickel-bronze material have operated for 20,000 cycles without failure or excessive wear.

Some limitations are:

1. Cannot be locked in intermediate positions.
2. Length of cylinder must be increased to provide room for the lock.
3. Rotation of piston is limited when sequence valves are used.

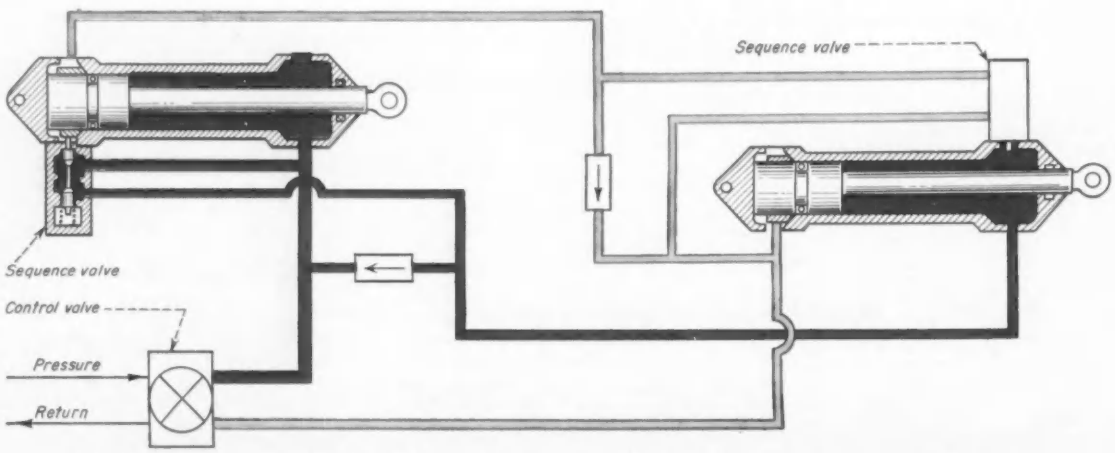
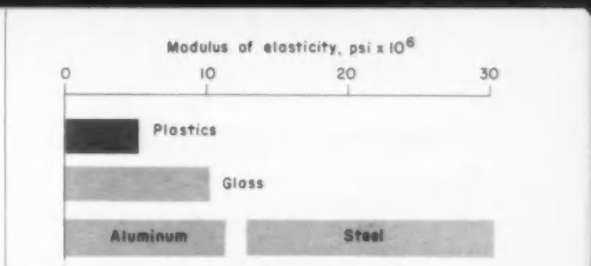
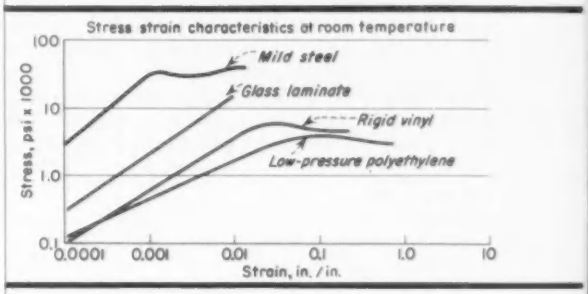


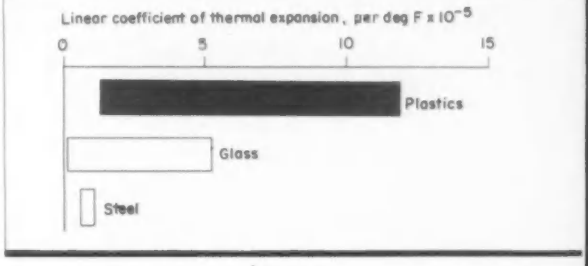
Fig. 6—Automatic sequencing circuit for toggle-lock actuator shown in Fig. 5. Pressure retracts the actuator at left which, upon locking, actuates the sequence valve. The valve then ports pressure to retract the actuator at right.

Copyright 1956
by McGraw-Hill Publishing Company, Inc.

Plastics FOR STRUCTURAL USES







Because of new developments in materials, processing technique and methods of lubrication, plastics are now suitable for many load carrying applications that were previously impractical. These developments are summarized herein. More important, they are classified in terms of design requirements: chemical resistance; temperature resistance; mechanical properties; dimensional stability and production methods.

PLASTICS are not dimensionally precise materials like metals. As shown in Fig. 1 (above), coefficients of expansion are higher, elastic modulus values lower and stress-strain characteristics more varied than those of most structural metals. In addition, selection of materials is more closely related to methods of fabrication. Injection molding, which accounts for the largest volume of parts being produced today can only be used with thermoplastic materials; thermosetting resins which set or harden in permanent shape when heated, must be produced by compression or transfer molding.

A new electric razor case offers a good example of this interrelation between materials and fabrication. Primarily because of cost, the original choice of material was phenolic. However, to improve appearance a white case was desired, so it was necessary to change from phenolic to urea. The housing design called for an undercut in the case. This required changing from compression to transfer molding. Because urea is not readily molded by the transfer method, it was necessary to change to melamine. To avoid color matching problems between case and cover melamine was also used for the cover even though this part was best made by compression molding.

Anisotropy or directional properties are a more important factor in plastics than in most metals. It is present in varying degrees in nearly all parts regardless of the method of fabrication. Extruded sheet material is usually highly directional in physical properties. Injection moldings are anisotropic in the direction of the flow of material into the mold. Superimposing high internal strains resulting from rapid cooling may make a part subject to failure by thermal shock as well as mechanical loading.

Compression and transfer molding results in some anisotropy, though not usually as pronounced as injection molding. The directional effect is generally related to the flow forces that orient the filler materials.

Other properties of particular importance in structural uses are discussed on pages that follow.

Thermoplastics vs Thermosets

MOST OF THE PLASTICS used for industrial applications are classified in Table I. This classification is useful because, in spite of new developments in formulations and processing that broaden the range of properties and characteristics of materials of both types, it is often possible to simplify a selection problem by keeping in mind the properties and characteristics unique to each of these two basic classifications. For example, a thermoplastic material probably should be used where:

1. High temperature resistance is not required. With the exception of nylon and a few special formulations, thermoplastic materials cannot be used above 180 F.

2. Large volume of parts are required at minimum cost. Most thermoplastics can be injection molded readily and when die cost can be amortized over a large volume, cost per part will generally be less than that of thermosetting materials. Cycle time to produce a thermoset molding may be three times as long as the cycle for the same size and shape part produced as a thermoplastic injection molding.

3. Range of colors or transparency is desired. Melamines and ureas are two exceptions, as shown in Table I.

4. Low electrical power loss is important, as for wire coverings.

5. Flexible material is needed. There is no thermosetting counterpart to materials such as the flexible vinyls.

6. Shapes can be produced in continuous lengths by extrusion and cut to desired sizes.

Thermosetting materials, in general, have these advantages:

1. Higher temperature resistance. Phenolics, for example, can be used at 350 F and special polyesters can go as high as 500 F.

2. Relative freedom from static electricity.

3. Better arc resistance.

4. Higher hardness.

5. Better chemical resistance. Most thermoplastics will be attacked by some family of solvents or chemicals.

6. Better weather resistance, especially the polyesters.

7. Higher tensile strength.

8. Wider choice of filler materials.

9. Lower total tooling costs except

Table I—Common Plastics Molding Materials

Material	Typical Applications	Principal Suppliers*
THERMOPLASTIC		
Acrylic	Windows, canopies, dials, luminated panels (transparent and tinted)	American Molding Powder & Chemical Corp.; E. I. du Pont de Nemours & Co., Inc.; Gering Products, Inc.; H. Muehlstein & Co., Inc.; Reed Plastics Corp.; Rohm & Haas Co.; Milton M. Siegel.
Alkyd		Barret Div., Allied Chemical & Dye Corp.; Hammond Plastics, Inc.; Plumb Chemical Corp.
Cellulose Acetate	Containers, handles, sheeting, film	American Molding Powder & Chemical Corp.; Celanese Corporation of America; Collins, Caldwell & Dague; Eastman Chemical Products, Inc.; Gering Products, Inc.; Hammond Plastics, Inc.; Hercules Powder Co.; H. Muehlstein & Co., Inc.; Omni Products Corp.; Reed Plastics Corp.; Milton M. Siegel.
Nylon	Gears, bearings, cams, bushings, coatings for metal parts, rollers (limited colors available)	American Molding Powder & Chemical Corp.; Barret Div., Allied Chemical & Dye Corp.; E. I. du Pont de Nemours & Co., Inc.; Hammond Plastics, Inc.; H. Muehlstein & Co., Inc.; The Polymer Corporation of Pennsylvania; Milton M. Siegel.
Polyethylene	Pipe, liners for tanks, containers, valves, cable and wire covering, packaging material (film), insulators, pumps (wide range of colors)	American Molding Powder & Chemical Corp.; Bakelite Co., Div. Union Carbide & Carbon Corp.; Collins, Caldwell & Dague; The Dow Chemical Co.; E. I. du Pont de Nemours & Co., Inc.; Eastman Chemical Products, Inc.; Fullerton Manufacturing Co.; Gering Products, Inc.; Hammond Plastics, Inc.; Koppers Co., Inc.; Monsanto Chemical Co.; H. Muehlstein & Co., Inc.; Omni Products Corp.; Phillips Chemical Co.; Reed Plastics Corp.; Milton M. Siegel; Spencer Chemical Co.; U. S. Industrial Chemicals Co.
Polystyrene	Radio and TV cabinets, housings, containers, sheeting, insulation (foam) (wide range of colors)	American Molding Powder & Chemical Corp.; Bakelite Co., Div. Union Carbide & Carbon Corp.; Catalin Corporation of America; Collins, Caldwell & Dague; The Dow Chemical Co.; Foster Grant Co., Inc.; Gering Products, Inc.; Hammond Plastics, Inc.; Koppers Co., Inc.; Monsanto Chemical Co.; H. Muehlstein & Co., Inc.; Omni Products Corp.; Milton M. Siegel; Walsen Consolidated Mercantile Co.
Vinyl	Rigid: pipe, pumps, filters Flexible: insulation, covering for wire and cable, pipe and tubing (wide range of colors)	American Molding Powder & Chemical Corp.; Bakelite Co., Div. Union Carbide & Carbon Corp.; Cary Chemicals, Inc.; Collins, Caldwell & Dague; Elastomer Chemical Corp.; Fullerton Manufacturing Corp.; Gering Products, Inc.; B. F. Goodrich Chemical Co.; Hammond Plastics, Inc.; Monsanto Chemical Co.; Naugatuck Chemical, Div. U. S. Rubber Co.; Omni Products Corp.; Milton M. Siegel; The Stanley Chemical Co.
Silicone		Bakelite Co., Div. Union Carbide & Carbon Corp.; Barrett Div., Allied Chemical & Dye Corp.; Dow Corning Corp.; General Electric Co.
THERMOSETTING		
Epoxy	Agitator for washing machines, potting compounds, handle. Recent applications in reinforced form for mechanical and electrical components.	Bakelite Co., Div. Union Carbide & Carbon Co.; Ciba Co., Inc.; Furane Plastics, Inc.; The Marblette Corp.; Rezolin, Inc.; Shell Chemical Corp.
Melamines	Heat resistant knobs, handles, housings for business machines (wide range of colors)	American Cyanamid Co.; Barrett Div., Allied Chemical & Dye Corp.; Fiberite Corp.; Monsanto Chemical Co.; H. Muehlstein & Co., Inc.; Omni Products Corp.; Texas Glass Fiber Corp.
Phenolic	Housings, electrical components. Laminates used for gears and other mechanical applications. (colors limited to red, black, green and brown)	American Reinforced Plastics Co.; Bakelite Co., Div. Union Carbide & Carbon Corp.; The Borden Co.; Dunnican Associates; Durez Plastics Div., Hooker Electrochemical Co.; Fiberite Corp.; General Electric Co.; Loven Chemical of California; Monsanto Chemical Co.; H. Muehlstein & Co., Inc.; Omni Products Corp.; Plastics Engineering Co.; Reilly Tar & Chemical Corp.; Rogers Corp.; Texas Glass Fiber Corp.; The Watertown Manufacturing Co.
Polyester	Principal use is with glass reinforcement for structural components in aircraft, machine tools, autos, appliances, etc. (colors can be added)	American Cyanamid Co.; Barrett Div., Allied Chemical & Dye Corp.; Cordo Molding Products, Inc.; Flexfilm Products; Interchemical Corp.; Mobile Plastics Div., Carlisle Corp.; H. Muehlstein & Co., Inc.; Plumb Chemical Corp.; Texas Glass Fiber Corp.; Thalco; Thermaflow Chemical Corp.
Urea	Electrical outlets, knobs, handles, housings (available in many colors)	American Cyanamid Co.; Barrett Div., Allied Chemical & Dye Corp.; The Borden Co.; Dunnican Associates; H. Muehlstein & Co., Inc.; Omni Products Corp.; Sylvan Plastics, Inc.; Texas Glass Fiber Corp.

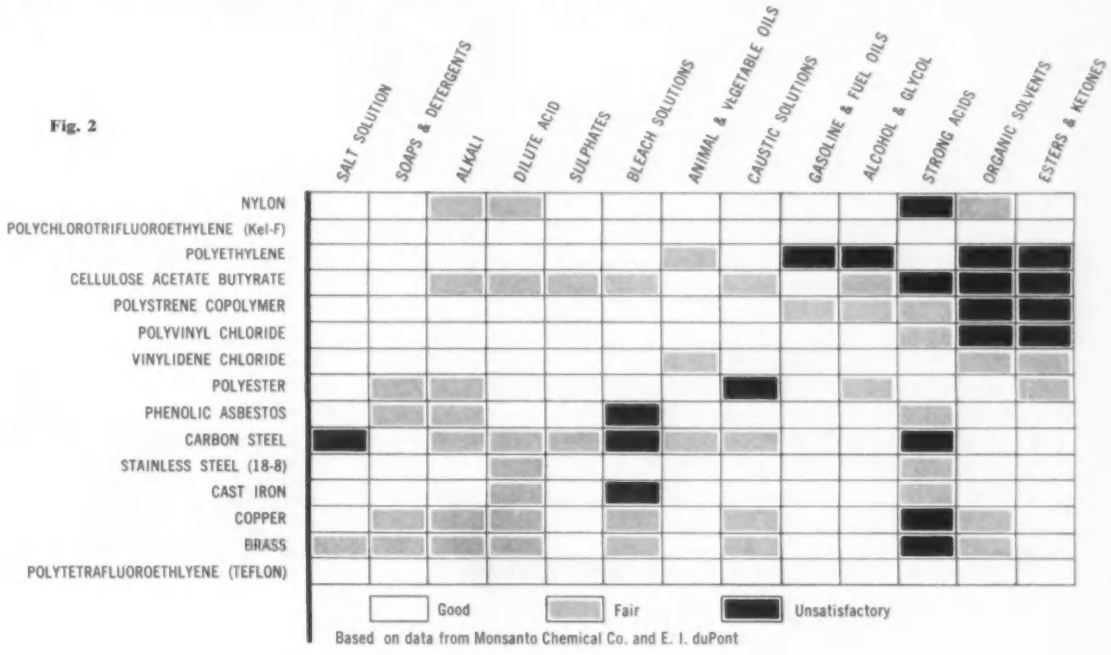
*As listed in **SPI Directory, 1955-1956,** Material Index, page 348.

where thermoplastic parts are produced by vacuum forming.

Thermoplastics as a group have better aging characteristics than thermosets, but for outdoor applications most thermoplastics are not satisfactory. For example, polystyrenes turn yellow and straw-like in appearance and get brittle. An outstanding exception, however, is the acrylic sheet material used in signs, buildings and automobiles. The tinted transparent roof sections introduced on several 1954 cars are a good example of such applications. Although acrylics are best known for their use in sheet form as aircraft cockpit canopies, windows and instrument panels, they are also available in the form of molding powders. Extensive use is now being made of these powders for automotive tail light and stop light lenses as well as nameplates, control knobs, dials and handles on all types of home appliances. A significant development is the extrusion of acrylic sheet from molding powder for use in lighting fixtures and partitions. A new general-purpose cast sheet produced by Rohm & Haas Company has the same physical and chemical properties as standard acrylic sheet and costs 10 to 25 per cent less.

Considerable development work is being carried on to improve the weather and sunlight resistance of all thermoplastics. E. I. duPont recently announced a nylon formulation available only in black that resists ultraviolet degradation making it possible to use molded nylon parts in prolonged outdoor service.

Fig. 2



Based on data from Monsanto Chemical Co. and E. I. duPont

Chemical Resistance

AMONG THE MOST IMPORTANT PROPERTIES of plastics are chemical and corrosion resistance. This, plus the fact that they can be fabricated by a variety of methods and formed into durable shapes from thin films to thick sheets and moldings makes them useful for applications like tank liners, piping, valves and containers.

Most of the materials used for such application are classified in Fig. 2, according to resistance to acids, solvents and other solutions. One of the most inert of these materials, polyethylene, will be available in high-modulus (low pressure) types with physical and mechanical properties considerably better than general-purpose formulations. Detailed data are given in the section on Mechanical Properties.

Where temperature resistance as well as corrosion resistance is needed, fluorocarbon is outstanding. Recent developments in the field include new fluorocarbon polymer dispersions (M. W. Kellogg Co.) that can be applied to many metallic and some non-metallic surfaces to prevent chemical attack and corrosion. These produce tough, continuous coatings with all the important characteristics of fluorocarbons. Cost of these materials, however, is often prohibitive.

A new German process for which Polymer Processes, Inc., a subsidiary of The Polymer Corporation, now has patent and licensing rights in this country, can be used to coat metals, ceramics, glass and wood with a range of plastic materials including nylon, polyethylene, polystyrene, cellulose acetate butyrate, acrylics, and epoxy resins. This method, reported to require relatively inexpensive equipment, consists of dipping preheated parts into a dry fluidized bed of plastic material in finely divided solid form. Coating thicknesses for nylon have ranged from 0.008 to 0.020 in., while thicknesses for polyethylene have been between 0.010 and 0.040 in Fig. 3 shows some typical applications for nylon coated parts.

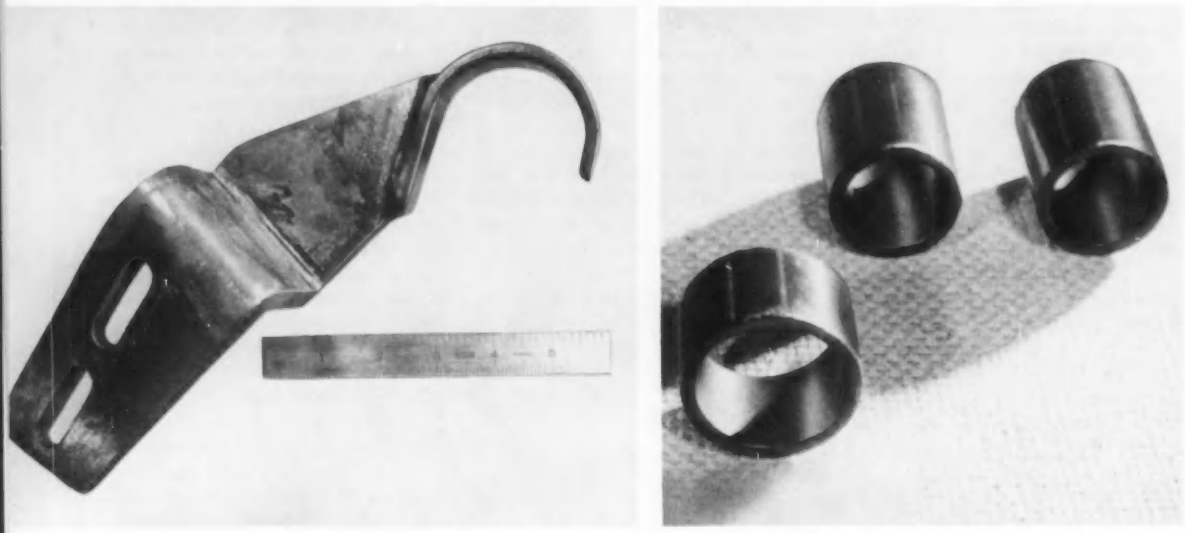


Fig. 3—Nylon coated steel parts combine strength and dimensional stability of the metal with wear and abrasion resistance, low surface friction and anti-galling properties of the plastic. Loading hook (A) is used to convey highly polished parts without scratching the surfaces. Coated bushings (B) have better dimensional stability with temperature and moisture than all plastic parts. Also, metal tends to dissipate heat from wear surface. POLYMER PROCESSES, INC.

THE STRENGTH RANGE of plastic materials is broader by far than that of any one of the other structural materials. Depending upon the composition and the type reinforcement used it is possible to have more than a two-hundred fold variation in tensile strength.

However, tensile strength is not as precise an indication of load carrying capacity as it is with metals. It is usually necessary to take several mechanical properties as a group to make an accurate analysis. For example, the tensile strength of nylon

Mechanical Properties

Table II—Mechanical Properties of Uncompounded Plastics

	Tensile Strength, psi	Compressive Strength, psi	Flexural Strength, psi	Impact Strength Izod, ft lbs/in. notch	Specific Gravity	Heat Distortion (264 psi), deg F	Modulus of Elasticity psi x 10^4	Coefficient of Thermal Expansion, per deg C x 10^{-5}
Epoxy	12,000	17,000	20,000	0.5	1.2	210	4.5	—
Nylon	10,500	—	13,800	1.0	1.14	360	2.0-4.0	10-15
Melamine	9,000	40,000	13,000	0.4	1.5	—	—	—
Polyvinyl chloride (rigid)	8,000	10,000	13,000	0.7	1.4	165	5.6	5-6
Modified styrene copolymers	8,000	—	15,000	0.5	1.05	190	4-6	3.5-12
Phenolic	7,500	15,000	15,000	0.3	1.3	—	7-10	2.5-6
Urea	7,500	30,000	14,000	0.3	1.5	—	15	2.5-3.0
Vinyl chloride acetate (rigid)	7,000	10,000	13,000	0.6	1.4	145	3.5	7-17
Methyl methacrylate (acrylic)	7,000	12,000	13,000	0.5	1.2	170	4.5	9
Polystyrene	7,000	16,000	11,000	0.35	1.05	185	4-6	7
Polyester	6,000	20,000	12,000	0.3	1.3	—	3-6.5	5.5
Cellulose acetate	6,000	20,000	—	2.0	1.3	145	2.5-3.0	8-16
Styrene-rubber blends	5,000	7,000	9,000	8	1.05	175	1.8-4.0	6-13
Silicone	4,000	9,000	8,000	8	1.7	550	—	2.0
Alkyd	3,500	19,000	9,000	0.3	2.2	375	—	—
Polytetrafluoroethylene	1,800	—	—	3.0	2.2	270	0.5-0.6	10
Polyethylene (general purpose)	1,300	—	—	—	0.92	175	0.25-0.50	17
Polyethylene (high density)	3,200	—	—	2.5	0.93	250	—	—

Table III—Typical Properties of Some High Impact Plastics

	RM 9725 Phenolic-Cellulose (Rogers Corp.)	Forticel (Celanese Corp.)	Formulation G High Impact Styrene (Catalin Corp.)	Cycolac (Marbon Chemical)	Kralastic (Naugatuck Chemical)
Specific Gravity	1.38 (aver)	1.18-1.21	1.04	1.01	1.02-1.08
Impact Strength (Izod), ft lb/in. of notch — 73 F	1.6 (min)	2.7-11	6-8	4.80	9 (max)
Impact Strength (Izod), ft lb/in. of notch — 40 F	—	—	—	1.60	3 (max)
Tensile Strength, psi	11,000 (min)	3,380-5,200	3,000-4,000	4,500	3,000-9,200
Flexural Strength, psi	16,000 (min)	6,400-8,500	—	6,800	—
Elastic Modulus (Tension) psi x 10^5	—	—	—	196,000	—
Flexural Modulus, psi x 10^5	—	—	—	184,000	1.7-5.1
Heat Distortion, deg F	310 (min)	160	155-192	183	172-208
Hardness, Rockwell	—	—	M55-65	R85	R62-R122

is only about 10,000 psi, yet there are many gearing applications where nylon gives months of satisfactory service whereas steel gears fail in a few hours. Besides being tough, wear resistant, and free from lubrication problems, nylon is quite resilient and somewhat flexible. Where only one pair of teeth carry the load with steel gears, nylon teeth may deflect so two or more pair share the load.

The elastic modulus of non-reinforced plastics is only a fraction of that of metal. Even with glass reinforced materials the maximum elastic modulus is about 1/10 that of steel (See page 183 in this issue.) Ductility varies even more; with even the more brittle types of plastics, elongation at failure in a simple tension test can vary from less than 1 to more than 800 per cent.

Toughness is recognized as an important property but is not clearly defined nor readily measured. In most instances it is interpreted as some combination of impact resistance, ductility, flexural strength and damping factor. Some authorities prefer to define this combination of properties as "abuse resistance."

The properties governing the selection of plastics for most mechanical applications are listed in Table II. To meet growing needs for materials with increased impact resistance as well as attempt to combine the mechanical properties of nylon with the dimensional stability and low cost of styrenes, a new group of plastics have been introduced which are often classified as high-impact types. Table III lists the trade names, manufacturers and properties of several typical formulations. Fig. 4 shows a typical application. These materials are com-

Table IV—Typical Properties of Low Pressure Polyethylene

Property	Test Method	Range of Values
Specific Gravity	ASTM-792-50	0.93-0.95
Tensile Strength, psi	ASTM-D638-52T	2800-5500
Elongation in Tension, per cent	ASTM-D638-52T	400-100
Stiffness Modulus, psi	ASTM-D747-50	50,000-100,000
Impact Strength		
Notched Izod, ft lb/in. of notch	ASTM-D256-47T	1.0-5.0
Unnotched Izod, ft lb/in.	(70 F)	Over 32
Unnotched Izod, ft lb/in.	(−85 F)	Over 32
Tear Strength, lb/in.	ASTM-D1004-49T	600-1300
Hardness, Shore D scale	ASTM-D676-49T	63-70
Dielectric Constant, 80 mc	ASTM-D150-47T	2.2-2.3
Dissipation Factor, 80 mc	ASTM-D150-47T	Below 0.0005
Dimensional Stability, per cent	10 min @ 250 F (steam)	2-4
Brittleness Temperature, deg F	ASTM-D746-52T	Below −100 F
Flammability, in./min	ASTM-D635-44	0.9-1.1*
Deformation Under Load, per cent	ASTM-D621-51 50 C (122 F) Method B	0.40-0.05
Mold Shrinkage (Injection), in./in.	ASTM-D955-51	0.012-0.025**

*Slow burning.
**In direction of flow.

KOPPERS CO., INC.

Fig 4—For this garden hose chemical applicator requirements included good moldability, impact resistance and low cost. Produced from a rubber-resin blend (Table III), it is molded in two halves which are cemented together. NAUGATUCK CHEMICAL DIV.

pared with general types of plastics in Table II. Ranges of values shown indicate what can be accomplished by minor variations in formulation. However, if impact strength is increased by adding rubber or similar elastomers, there will be changes in other properties such as stiffness and hardness.

An outstanding development in the thermoplastics field was the introduction of low-pressure (also called high-modulus) types of polyethylenes. As illustrated by the data in Table IV, these materials have a stiffness modulus of 50,000 to 100,000 compared to 15,000 for regular polyethylene. Dimensional stability has also been improved; at 250 F changes in dimensions are from 1 to 4 per cent. Brittleness temperature is considerable below – 100 F and unnotched impact strength (Izod) exceeds 32 ft-lb/in. Tensile strength ranges from about 3000 to 5500 psi and does not decrease as much with increasing temperature as ordinary polyethylene.

Temperature Resistance

MORE ATTENTION is probably being devoted to increasing the maximum operating temperature of plastics than any other single property. What is accomplished will, to a large degree, determine the future of the plastics industry.

As shown in Table V, glass-bonded mica (typical example, Mycalex, Mycalex Corporation of America) is the highest temperature plastic type material now available. An inorganic material, glass-bonded mica is hard and much more brittle than organic plastics. Tensile strength is lower than most other ceramics but impact strength is better. Used primarily for electrical components, glass-bonded mica can be compression molded by pressing preheated preforms at 500-700 F at 4000 psi or injection molded at 600-1000 F and 10,000-30,000 psi.

Cold-molded plastics which are next in high temperature resistance comprise two groups – organic and inorganic – depending upon the type of binder. Organic materials include two types; bituminous binder and phenolic binder. Phenolic plastics have better electrical and mechanical properties as well as better surface finish.

Although cold-molded plastic parts must be baked after the material is formed into shape by pressure alone, production rates of 3000-4000 parts per hr can be achieved by curing a large number of pieces simultaneously in a large oven. Curing time may range from a few hours to a few days depending upon the size and cross section of the part.

In general, cold-molded plastic parts differ considerably in dimensions, have a dull finish, and are limited to black, brown and green colors. By virtue of compound modifications and improved processings some advances have been made recently.

With some newer compounds, dimensional stability and design flexibility of this process have been improved. Mechanical properties have been improved; baking is not necessary unless high tensile strength is essential. Some powders are adaptable

Table V—Temperature Limits for Various Plastics, F

Glass-filled mica	700-1000
Cold-molded plastic (organic), sustained service	500
Polytetrafluoroethylene, sustained service, no load	500
Cold-molded plastic (organic) heat distortion	400
Polyester-glass, heat distortion	400
Cellulose-filled melamine, heat distortion	400
Polymonochlorotrifluoroethylene, sustained service, no load	390
Polyester mineral-filled molding compound, heat distortion	375-425
Alkyd, mineral-filled, granular, heat distortion	350-400
Epoxy-glass cloth, max temp	315
Silicone elastomer, sustained service	300-500
Nylon, heat distortion, 66 psi	300-360
Urea, heat distortion	275
Polytetrafluoroethylene, heat distortion, 66 psi	270
Melamine, filled, heat distortion	266-400
Diallylphthalate, alpha cellulose filler, heat distortion	265-310
Phenolic, mica-filled, heat distortion	260-350
Phenolic, wood flour filled, heat distortion	260-340
Polyethylene, low pressure types	250
Paper-phenolic laminate, sustained service	212-250
Styrene elastomer, max temp	212
Epoxy, max recommended use	212
Acrylic, molded	168-208
Polystyrene, heat distortion	152-210
Styrene copolymer, heat distortion	148-235
Vinyl chloride, heat distortion	140-185
Vinylidene chloride, heat distortion	130-150
Cellulose acetate butyrate, heat distortion	120-210
Cellulose acetate, heat distortion	115-235
Vinyl butyral, heat distortion	115-140
Polyethylene (general purpose), heat distortion, 66 psi	107

Table VI—Typical Properties of Methylstyrene-Acrylonitrile Copolymer

(American Cyanamid Cymac 201)

Specific Gravity	1.06
Water Absorption, per cent in 24 hr	0.31
Mold Shrinkage, in./in.	0.0035
Shrinkage, per cent, 30 min @ 100 C	0.00
150 min @ 100 C	0.24
Heat Distortion Point, deg F	207
Distortion, in. after 15 min in 212 F water, 264 psi load	0.06
Impact Strength, Izod ft lb/in. notch, 1/4 in. bar	0.35
Tensile Strength, psi	9,700
Elongation, per cent	2.5
Flexural Strength, psi	16,000
Modulus of Elasticity, in flexure, psi	4.6×10^5

Editor's Note. As part of a continuing coverage of significant developments in the plastics field, the following articles have appeared in recent issues of Product Engineering:

"Resins for Reinforced Plastics," F. Schlieben, May 1956 page 198.

"Silicone Rubber," S. K. Moxness, March 1956 page 173.

"Fillers and Reinforcements for Molded Plastics," George Lubin, December 1955 page 178.

"Kralastics–A New Thermoplastic Material," E. J. Trunk, November 1955 page 171.

"Metallized Plastic Films," Thomas Hammer, August 1955 page 182.

Table VII—Tentative Mechanical and Physical Properties of Silicone Molding Materials

Property	Test Procedure	General Purpose Mineral-Filled	High Impact
Tensile Strength, psi	D651-48		
23 deg C		4000-4300	4,700-5,000
200 deg C		1200-1800	1,200-1,800
Flexural Strength, psi	D790-49T		
23 deg C		6800-7500	9,000-11,000
200 deg C		2000-2500	2,500-3,500
Modulus of Elasticity in Flexure, psi	D790-49T		
23 deg C		$10\text{-}13 \times 10^5$	$17\text{-}19 \times 10^5$
200 deg C		$4\text{-}5 \times 10^5$	$6\text{-}8 \times 10^5$
Izod Impact Strength, ft lb/in. notch	D256-47T	0.25-0.30	3.00-6.00
Compressive Strength, psi	D695-49T		
23 deg C		16,000-20,000	13,000-15,000
200 deg C		5000-7000	2,000-4,000
Molded Specific Gravity	D392-38	1.8-2.0	1.8-2.0
Rockwell Hardness, M scale			
23 deg C		89	
100 deg C		66	
Heat Distortion, deg C	D648-45T	255	255
Water Distortion, per cent wt gain	Mil-P-14D (D48/50)	0.3-0.4	0.4-0.5
Arc Resistance, sec	D495-48T	300-420+	250-350
Flame Resistance, sec	LP-406A No. 2023		
Ignition time		186-220	90-125
Burning time		40-50	25-100
Linear Coefficient of Expansion, 20 to 100 deg C, cm/deg		5.0×10^{-5}	

(BAKELITE CO.)

to rotary presses and as many as 300 small parts can be pressed per hr.

As noted previously, thermosetting materials can operate at considerably higher temperatures than most thermoplastics. These data, however, are generalized and do not include special formulations developed recently. For example, Table VI lists the properties of a new injection molding compound developed primarily to meet Underwriters' specifications for radio and TV cabinets utilizing printed circuits. Because of the reduced air circulation and the possible dangers from the exposed conductors on printed circuits, this specification requires seven hours at 95 C without distortion. Some new polystyrenes are also aimed at meeting these requirements.

Besides having a low heat distortion limit, plastics as a rule have a sharp decrease in mechanical properties with increasing temperature. This can be offset to some extent by proper choice of filler materials. Mineral fillers in particular are useful.

Silicones are an example of new molding compounds of this type being developed, as illustrated in Table VII. As shown in Fig. 5, (above) flexural strength is essentially constant at 200 C exposure for about a year.

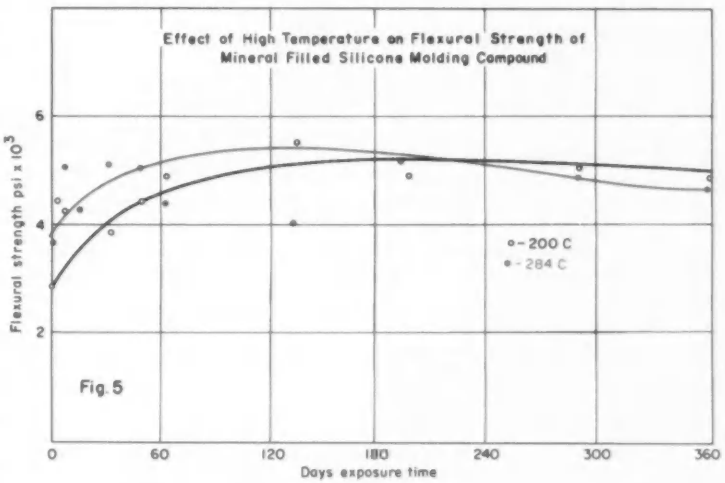
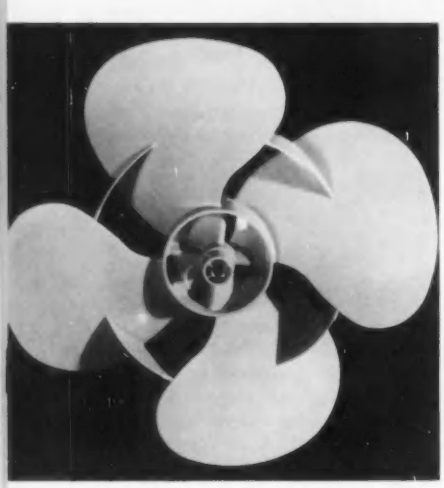


Fig. 5

In selecting a molding material on the basis of temperature distortion, an allowance must be made if the fabricated part will have internal strains. For injection moldings of complicated shapes, for example, the true distortion temperature may be 15-20 degrees lower than the value obtained with simple test specimens.

Another important point is relative flammability of the resin. In the case of polyester resins, considerable success has been achieved. Hooker Electrochemical Company lists the flame spread rating of their fire resistant polyesters as 50-75 in comparison with 400 for conventional polyester sheet, 0 for asbestos, 100 for oak and over 500 for veneered wood.

Dimensional Stability



WORCESTER MOULDED PLASTICS CO.

Fig. 6–Control of dimensions and uniformity of material is such that this fan requires no dynamic balancing. When using a metal insert in a part such as this, mold shrinkage properties of material are important to avoid cracking around insert.

SINCE MOST PLASTICS are organic compounds, they have inherent instabilities of one type or another. In addition to the effect of temperature and internal strains noted previously, these instabilites include: (a) mold shrinkage; (b) age shrinkage – effects of humidity, drying and cycling when no load is applied; (c) cold flow; (d) water absorption; and (e) volatization of compound and plasticizers.

Mold Shrinkage

Mold shrinkage is defined as the difference between the size of a piece after it has reached equilibrium and the size of the cavity in which it was molded. Thus, it is an important factor where dimensions and tolerances must be kept within close limits, particularly for mating parts.

Furthermore, if metal inserts are to be molded in a part, a material with low shrinkage must be used to avoid cracking and crazing of the plastic around an insert such as shown in Fig. 6. In general, shrinkage values vary as follows:

Decrease with increasing plastic temperature, increasing press size, and with multiple gates.

Increase with higher die temperatures, smaller gates and runners, and as mold-closed time is decreased.

Typical values for several plastics are given in Table VIII. These will vary of course in accordance with the variables listed above. For materials not listed, water absorption characteristics can be used as a guide to mold shrinkage.

Table VIII–Typical Mold Shrinkage Values for Various Plastics (in./in.)

Cellulose Acetate	0.005
Methyl Methacrylate	0.005
Vinyl (rigid)	0.001
Nylon	0.015
Polyethylene	0.035
Styrene	0.003

Age Shrinkage

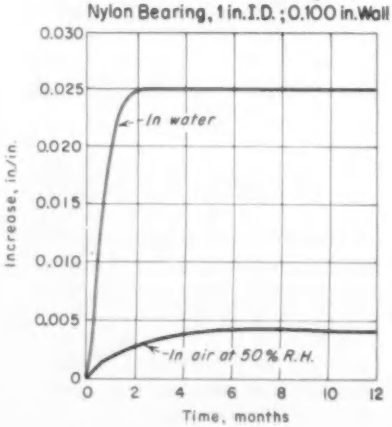
THIS PROPERTY is attributed to the fact that many plastics do not attain complete equilibrium in a short period of time at room temperature. It is evidenced as a slight but continuous shrinkage over a period of 30 days or more. The magnitudes involved are a function of material, part size and shape and molding conditions. Table IX lists data on dimensional changes in molded disks that show aging shrinkage and effects of humidity.

In general, thermosetting materials are more susceptible to aging shrinkage than thermoplastics. However, this will to a large degree be determined by the amount of plasticizer used, which may cause shrinkage on evaporation.

Cold Flow

A practical definition of cold flow is a change of dimensions caused by a sustained load that stresses the material beyond its elastic limit at a

Fig. 7 Change in Bore Diameter with Moisture Absorption
Nylon Bearing, 1 in. I.D. ; 0.100 in. Wall



Effect of Temperature and Humidity on Elastic Modulus

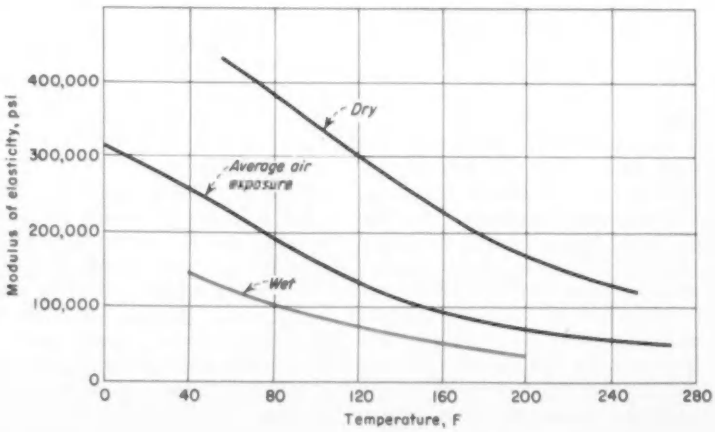


Table IX—Linear Dimensional Change of Molded Plastic Disks (in./in.)

Material	Test Conditions: 5 days at 120 F dry	5 days at 120 F, 86 per cent R. H.	5 days of 16 hr at 120 F and 86 per cent R. H. plus 7 hr at 160 F
Polystyrene	—0.0002		—0.0002
Methyl Methacrylate, general purpose	—0.0003	+0.0020	+0.0009
Phenolic, mica-filled	—0.0005	—0.0005	—0.0005
Phenolic, general purpose	—0.0008	+0.0005	—0.0005
Urea Formaldehyde	—0.0060	+0.0030	+0.0010
Melamine, mineral filled	—0.0010	+0.0010	—0.0007
Melamine, cellulose filled	—0.0080	+0.0042	—0.0003
Cellulose Acetate—Butyrate	—0.0014	+0.0042	—0.002
Cellulose Acetate	—0.009	+0.010	
Polyvinyl Chloride—Acetate	+0.0006	+0.0010	—0.0006

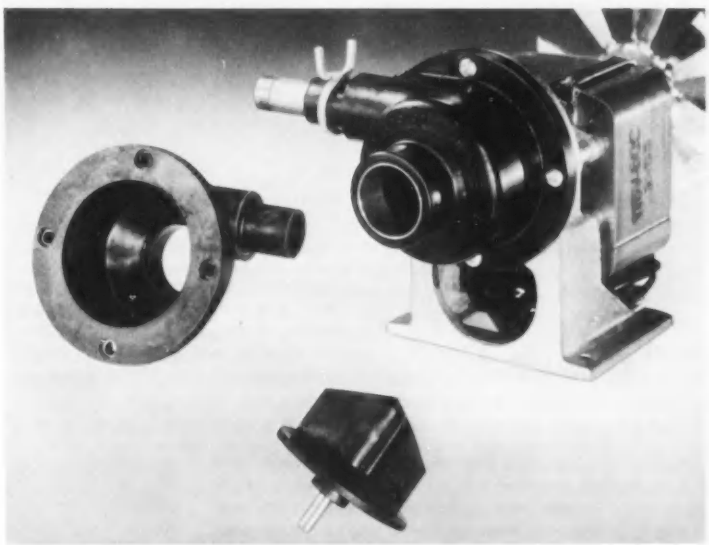


Fig. 8—Pumps with polyethylene housing and impeller are now in extensive use in automatic washers and dryers, dishwashing machines, and fruit juice dispensers. Particularly well suited to the household appliance field, the polyethylene pump parts are non-corrosive and economical to produce. They also offer good tensile strength and hardness and can withstand high temperatures and high detergent concentration.

EASTMAN CHEMICAL PRODUCTS, INC.

Fig. 9—A submersion tank tests glass reinforced industrial cases under heat and pressure for water-tightness. These cases are completely air and water tight and have a zero rate of moisture and vapor transmission. H. KOCH & SONS

Table X—Cold Flow Characteristics

Material	Per Cent
Heat Resistant Polystyrene	0.36
Phenol—Formaldehyde	0.4
Acrylics	0.5
General Purpose Polystyrene	0.6
Urea—Formaldehyde*	0.4-3.0
Polyvinyl Chloride*	1.0-8.0
Cellulose Acetate*	2.0-10.0
Cast Phenol—Formaldehyde	10.0
Hard Rubber*	0.5-20

*Depending on formulation

Table XI—
Water Absorption Characteristics

Material	Water Absorbed per cent, 24 hr
Polychlorotrifluoroethylene (Kel-F)	0.000
Polyethylene	0.000
Polytetrafluoroethylene (Teflon)	0.005
Polyethylene, low modulus	0.005-0.015
Polystyrenes	0.04
Vinyls	0.07-0.08
Epoxies	0.08-1.3
Polyester, glass filled	0.15-0.21
Melamines	0.1-0.3
Phenolics	0.3-1.7
Ureas	0.4-0.8
Polyester	0.4-0.8
Nylon	0.5-1.5
Cellulosics	1.1-5.9

temperature below the heat distortion point. Data on this property are not generally available at present but the values in Table X, which were compiled from the results of scattered investigations, can be used as a rough comparison of different materials.

Water Absorption

As shown in Table XI, polyethylene, Teflon, Kel-F and polystyrene have a water absorption of 0.04 per cent or less. This is important where parts may warp or swell from water immersion.

Nylon is probably the most widely used plastic for mechanical applications such as gears, bearings and bushings, but has given designers and molders considerable difficulty because of dimension changes resulting from moisture absorption. For example, the curves in Fig. 7 compare the change in diameter of a 1-in. bearing when immersed in water as contrasted to a similar bearing operating in air with 50 per cent relative humidity. After the initial growth, the change is relatively slight.

As an indication of the requirements now being met with plastic parts, Fig. 8 shows a molded polyethylene pump; Fig. 9 shows reinforced plastic industrial cases being tested for water and moisture sealing.

Laminates

PLASTIC LAMINATES, made by impregnating a filler material with a resin solution, can be divided into two groups according to the pressure required to cure the resin or binder. If the pressure is less than 1000 psi the laminate is classified as low pressure. Reinforced plastics, which are usually molded at less than 400 psi are the most important material in this group and, as shown in Fig. 10, are now being used for machine tool housings as well as various structural components in the aircraft, marine and automotive fields.

High pressure laminates, which are usually cured at 1200 to 2000 psi are classified according to the filler material: paper, wood, fabric, metal, etc. Resins used include such thermosets as polyesters, phenolics, epoxies and melamines and a few thermoplastics like vinyl and cellulose acetate.

For electrical components, high pressure laminates, particularly the paper types because of cost, are useful because they are easily machined, dimensionally stable, have good mechanical properties, and are good insulators. An important new application is printed circuits.

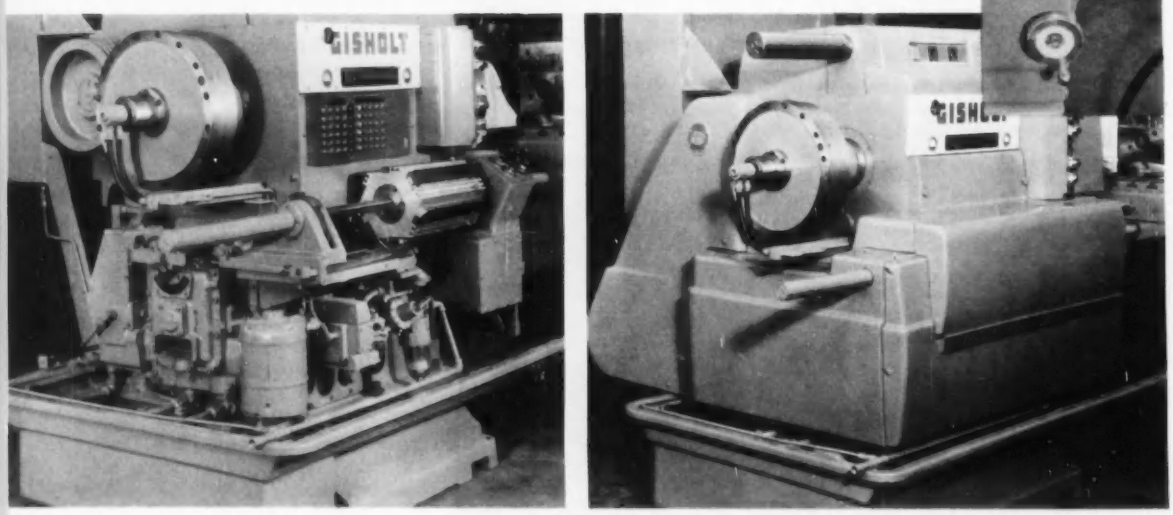
For mechanical equipment, gears made from high pressure laminates offer light weight, quiet operation, resistance to oils, moisture and solvents, as well as good strength and dimensional stability.

Metal laminates—usually steel covered with vinyl sheet—are particularly useful where a permanent type finish is required and where the color and texture of vinyls can be used to improve styling and appearance. Typical applications include housings for business machines and appliances, instrument panels, radio and TV cabinets. The laminate, produced in flat sheet in a continuous process, can be stamped, shaped, drawn, or embossed with designs and patterns. Design details for materials of this type will be given in an article to appear in the July issue of *Product Engineering*.

Many other types of laminates are available and others will be developed whenever the desirable properties of plastics can be supplemented advantageously by other materials. For example, plastic covered aluminum forms a corrosion resistant material with good insulating properties. Similarly, glass reinforced polyester sheet bonded to a core of paper honeycomb or foam could become an important structural material.

Deep drawn parts made from aluminum sheet with a film of vinyl bonded by a process developed by Naugatuck Chemical. Coating withstands deep drawing; may range from 8 to 20 mils thick.

Fig. 10 – Machine tool before and after installation of housings show how glass reinforced plastics offer reductions in weight, handling time and costs. Typical panel weighing 400 lb in cast iron, weighs 112 lb in aluminum and only 21 lb in reinforced plastic. Cost for cast iron or aluminum is about $160; with plastic cost is less than $50. Key factor in cost is usually in volume of parts required. If less than 20,000 parts are needed, tooling costs usually will be lower with reinforced plastic than for metal. Some automotive parts, however, are being produced in much larger volume with considerable savings. This is possible because molded part replaces assembly of several metal components. Inset shows handwheel and two dials made from premix molding compound reinforced with glass fibers. GISHOLT MACHINE CO.



Reinforced Plastics

FILLERS in the form of fibers and powders are added to plastics resins for improved properties, reduction in cost and better finish. Some powders have little effect on strength but may reduce processing or molding cost, produce an optimum value for a specific property, or reduce water absorption. Fibrous fillers are effective in increasing the strength and stiffness; longer fibers generally give higher strength; the strongest fibers give the highest strengths, increasing with fiber content up to about 60 per cent.

For mechanical applications glass fiber is the major reinforcement used. Major advantages are high strength and stiffness, uniformity in properties, and suitability for low pressure molding. The glass is used in many forms: fabrics in several weaves and nonwoven mats bonded with adhesive, or loose fibers.

Asbestos is also used as a fibrous filler, to a much greater extent in England than here. While competing directly with glass fabric materials in some applications, asbestos fibers generally are used where stiff, rigid laminates are needed. Strength and specific gravity are the same as for glass reinforced laminate, but the modulus of elasticity of asbestos is about 50 per cent higher. Bending strength of asbestos laminate is strongly influenced by filler content; both strength and modulus reach a peak at about 60 per cent filler content.

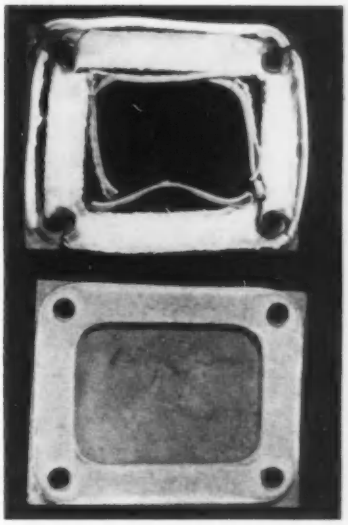


Fig. 11—Comparison of cold flow and heat resistance properties of unfilled (top) with glass-filled Teflon gasket (bottom). Both parts were exposed to 500 F for period of several hours. Outstanding properties of Teflon for mechanical applications are toughness over wide temperature range, low coefficient of friction, heat resistance and chemical inertness. Deformation under load is improved by adding fillers such as glass, as illustrated above, asbestos, carbon, etc. Fillers may also be added to reduce raw material costs.

ROGERS CORP.

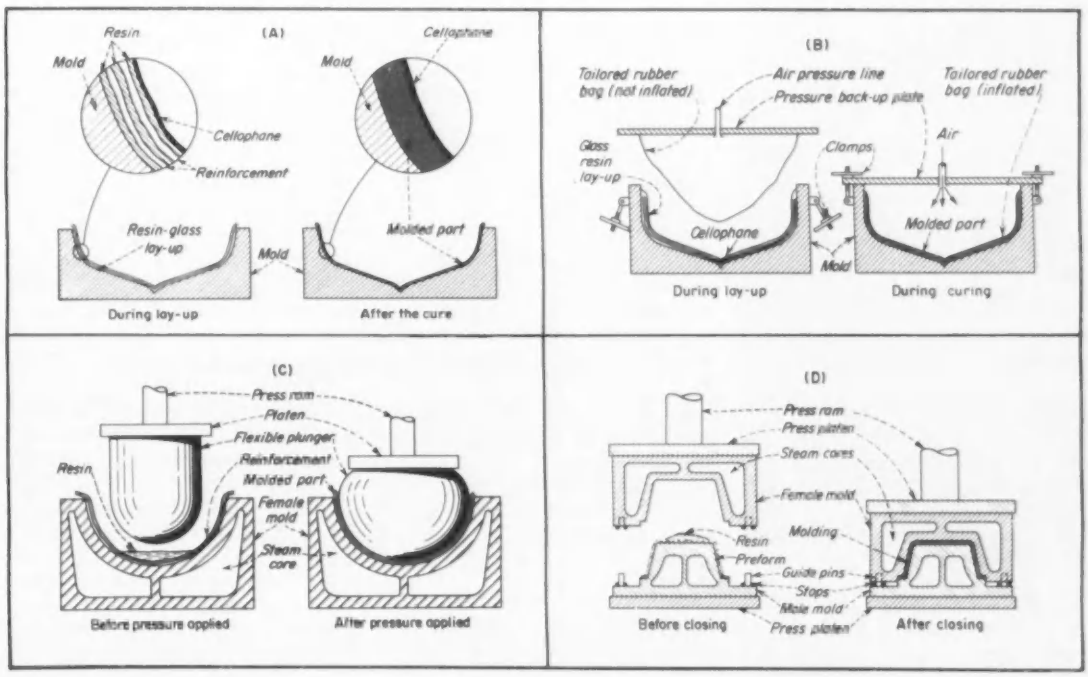


Fig. 12 CONTACT MOLDING (A)—Layers of reinforcement are placed by hand against the mold surface and saturated with resin. The material then is allowed to harden without external application of heat or pressure. PRESSURE BAG MOLDING (B)—Tailored bag placed against the sheeting and inflated applies pressures up to 50 psi against the impregnated reinforcement. FLEXIBLE PLUNGER MOLDING (C)—Reinforcement and resin are placed in a heated metal female or cavity mold. Medium hard rubber plug shaped like the part to be molded then is released, providing uniform, high and fluid pressures. MATCHED DIE MOLDING (D)—Used for high production runs and for parts up to 60 sq ft in area, this method uses two heated metal molds with a telescoping area which seals in the resin and trims the Fiberglas Reinforcement. On long runs, matched die molding gives the lowest cost and highest production rate.

Fig. 13—Molding underbody for 1956 Chevrolet Corvette. First step, (A), is spraying chopped glass fibers and binder on preform. After about 5 min cure, preform is placed on die and weighed quantity of polyester resin poured on mat as shown in (B). Underbody shown in (C) as it is being removed from press. Considerable amount of hand finishing is required, (D), to trim and prepare surfaces for painting. Where color matching is not the problem it is in automobiles, and where slightly fibrous texture of surface is acceptable, parts can be molded in color. Considerable improvement in surface can be made by using a finely woven glass cloth as an overlay on the preform.

MOLDED FIBER GLASS BODY CO.

Other reinforcing materials that have been used, although on a much smaller scale primarily because of cost, are nylon, Dacron and Orlon.

Although polyester is the most widely used resin in reinforced plastics, others including phenolics, epoxies and fluorocarbons are being produced. Properties of these materials are given in Table XII. Because of their tendency to adhere to dies, epoxies have been avoided by many molders. However, special separating compounds are now available that will prevent sticking. The gasket shown in Fig. 11 illustrates improvements in heat distortion and cold flow that are possible with glass reinforced fluorocarbons.

Methods of producing reinforced plastics are shown in Fig. 12. Of these, matched die molding offers the best combination of size range, uniformity of properties, volume production and tolerance control. The underbody illustrated in Fig. 13 is an excellent example of large parts that can be produced to metalworking tolerances.

In contrast to the underbody, which is an example of matched die molding using preforms, the business machine housings in Fig. 14 are molded in metal dies using a "premix" compound.

The premix method, sometimes called gunk molding, uses chopped fiber instead of mat or cloth, and the resin, usually polyester, is blended with fiber in a separate step before the mixture goes to the forming press. This eliminates the need for separate handling of fiber mats and liquid resin at the press. The operator merely drops a weighed quantity of premix compound into the mold, closes the press for the curing cycle and removes the finished molding.

Although the strength of premix moldings are only about 50 per cent of those of preform molding, Table XIII,

Table XII — Properties of Glass Fabric Reinforced Plastics

	Polyester	Epoxy	Melamine	Phenolic
Specific Gravity	1.6-2.0	1.7-1.9	1.82-1.98	1.5-2.1
Tensile Strength, psi	40,000-50,000	33,000-46,000	20,000-50,000	11,500-40,000
Tensile Modulus, psi x 10^6	1.0-2.8	2.5-3.5	—	1.0-2.0
Impact Strength, ft lb/in. of notch (Izod)	19-35	6-16	5-15	3.2-16
Heat Resistance, deg F, continuous	300-400	300-360	300	290
Flexural Strength	50,000-63,000	45,000-80,000	28,000-55,000	20,000-40,000
Compressive Strength, psi	30,000-60,000	50,000-90,000	30,000-85,000	42,000-60,000
Shear Strength, psi	12,000-18,000	17,000-22,000	19,000-30,000	17,000-24,000

Table XIII — Properties of Glass-Filled Premix Molding Compounds

	Polyester	Melamine	Phenolic	Polystyrene
Specific Gravity	1.7-2.0	1.90-2.0	1.75-1.95	1.30
Tensile Strength, psi	4,000-10,000	6,000-10,000	7,000-10,000	10,500
Tensile Modulus, psi x 10^6	1.6-2.0	—	3.3	1.28
Impact Strength, ft lb/in. of notch (Izod)	3-6	8-12	12-50	2.0
Heat Resistance, deg F, continuous	300	300	350-450	
Flexural Strength, psi	5,000-25,000	9,000-20,000	18,000 min	12,000
Compressive Strength, psi	20,000-26,000	10,000-25,000	17,000-26,000	14,500

the process has several advantages. Parts difficult to form from a mat because of contours or cut-outs can be produced and the simplified molding procedure makes the process adaptable to mass production techniques.

Applications for premix molding include housings for automotive heaters, fans and air conditioners as well as business machine housings. In addition to tooling costs considerably lower than required for similar parts in metal, these plastic housings have advantages of sound absorption and heat insulation, and fewer finishing operations.

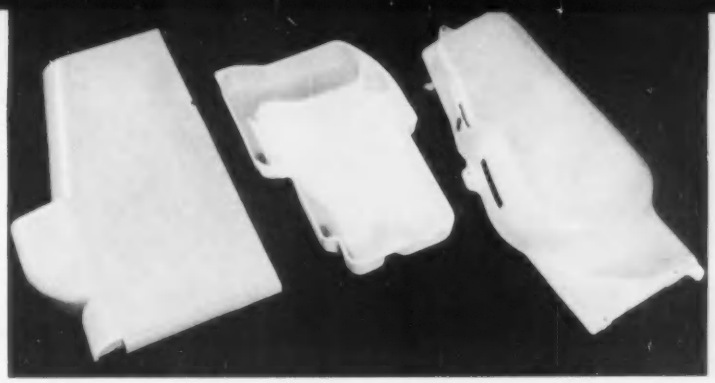


Fig. 14—Panels for business machine housings produced by molding premix thermosetting resins reinforced with glass fibers. Sound deadening properties of this material, satisfactory strength and lower tooling costs, are reasons for using plastic instead of sheet metal parts. MOLDED FIBER GLASS BODY CO.

Foam

FOAM MATERIALS can be divided into two groups: rigid and flexible. Rigid types of foams are used primarily as thermal and acoustical insulations, packing and potting materials, floats and wire coverings. Among these is cellular cellulose acetate which has a high ratio of strength to density, good machinability, excellent thermal and electrical properties and is resistant to water, chemical and decay. Densities range from 6 to 8 lb/ft^3.

Rigid vinyl foam may have either open or closed cell construction depending upon the process used. Closed cell types are used where buoyancy is required but the compression set characteristics are inferior to open cell types.

Polyethylene foam has good abrasion and chemical resistance, low moisture absorption, is flexible and tough and has good electrical properties. Density ranges from 2 to 30 lb/ft^3.

Phenolic foam, used extensively as a packaging and thermal insulating material, has a density of 0.3 to 0.4 lb/ft^3.

Isocyanate or polyurethane, which can be foamed in place, has good ratio of strength to weight, and good vibration damping characteristics. It adheres well to other materials such as wood, metal and fabrics, thus cementing is not usually required. Densities are 2 to 20 lb/ft^3.

Epoxies, which can also be foamed in place, have densities of 5 to 7 lb/ft^3.

Polystyrene foam ranges in density from 1½ to 2 lb/ft^3, is easily fabricated and heat formed. Since it is a thermoplastic, however, it should not be used under load above 175 F. It is cheaper than vinyl and isocyanate, but not as flexible or as durable. Also, it does not have equivalent thermal insulation or shock absorption properties.

Flexible foams include polyvinyl, cellulose, silicone sponge rubber, foamed latex, flexible vinyl and flexible polyurethane types.

Density of all natural rubber latex foam ranges from 3 to 10 lb/ft^3; vinyl from 6 to 8 lb/ft^3, polyurethane 2 to 5 lb/ft^3.

Advantages of vinyl foam are resilience that can be varied, inherent heat sealing since it is thermoplastic, good compression-deflection properties, and high strength. However, it has poor high temperature properties and poor compression set. Also it gets brittle at low temperatures unless specifically formulated for such service.

Flexible polyurethane offers lower densities for the same hardness, good compression set (almost as good as foamed latex), good mechanical properties, and resistance to high and low temperature. It does not get brittle at temperatures as low as –60 F.

Foamed latex has these advantages: Nearly constant deflection curve; high resilience; good low temperature properties; long flex life and low compression set. Disadvantages: Flammability, poor resistance to solvents and chemicals; poorer aging characteristics than vinyl or polyurethane.

Film and Sheeting

THE PRINCIPAL MARKETS for plastic sheeting materials are (1) packaging, (2) textile, (3) signs and displays. For films, the electrical component industry can be added. An outstanding development in this field is Mylar, a polyester film developed by duPont.

Available in gages from ¼ to 7½ mils (0.00025 to 0.0075 in.) this film has a good dielectric constant, high volume and surface resistivity and good mechanical strength. It can be used as a film or laminated to asbestos, rag, and kraft papers, glass and other materials. Tensile strength is 23,500 psi and the film remains flexible and stable from –60 to 300 F.

Electric motors are already using unsupported polyester film and laminations as slot liners and phase insulation. The film replaces bulkier materials, making it possible to build a motor of higher horsepower using the same frame or smaller motors of a given horsepower. Since polyester is insensitive to moisture, motors insulated with it can be used in extremes of weather and humidity without degradation of the insulation. Performance of motor and generator field coils also may be improved.

Other applications include thermal insulation. Bonded to aluminum foil, polyester film can protect primary insulation from moisture degradation, thus maintaining insulation effectiveness. Laminates of this type are useful as vapor barriers in commercial refrigeration equipment. Using asbestos paper, laminates can be made for steam and hot water pipe insulation.

Polyethylene film which is widely

used in the packaging industry for bags and wrapping can also be laminated to paper and foil, made into liners for bags, bottles and drums, and used in tape form as electrical insulation. As shown by Fig. 15, irradiated types of polyethylene have better mechanical properties and temperature resistance than ordinary polyethylene. However, the production of low pressure types by either the Ziegler or Phillips process promises to offset all advantages of irradiation except stability at high temperature. Irradiated parts are reported to be useful at 390 F.

Principal advantages of polyethylene in film, as well as in molding powder form, are combinations of good physical properties, ease of fabrication and low cost. Principal limitation is temperature distortion.

Vinyls are available in a wide range of hardness from flexible film to rigid sheet. Available in unlimited colors, vinyls are resistant to petroleum products, acids, alkalies, most chemicals, and many solvents. Mechanical properties, including tear strength, abrasion resistance and flexural strength are excellent for these plastic compounds.

Considerable development is being devoted in the styrene field to film and sheeting applications. Because of its dimensional stability, low moisture absorption, toughness and low cost per pound, styrene is expected to become an important packaging material. Much of the current effort is being devoted to producing thin-wall containers. About 0.032 in. is now standard but Monsanto Chemical has successfully made containers with 0.014 in. walls. With this development it is possible for styrenes to compete on a cost basis with heavy waxed paper for disposable cups.

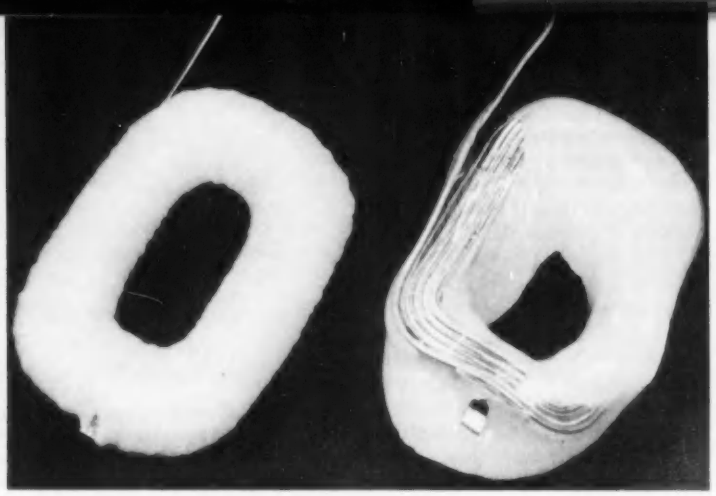


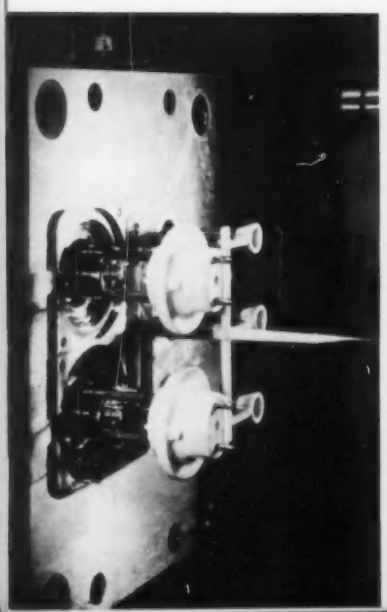
Fig. 15—Comparison of heat resistance of irradiated (left) and untreated (right) polyethylene tape. Both motor coils were exposed to 300 F. Available as packaging film as well as tape shown above, irradiated polyethylene can reduce amount of insulation required and thereby lead to development of smaller electrical equipment. However future of irradiated material may to a large extent be determined by the new, low-pressure polyethylenes which offer similar improvements in properties without irradiation of the plastic material. GENERAL ELECTRIC CO.

Injection and Compression Molding

BOTH INJECTION AND COMPRESSION MOLDINGS have been produced for several years, but current trends are for larger, more complex parts, shorter cycle times, and better reproducibility of physical properties through accurate control of molding temperature and pressure. Automatic equipment such as the injection machine on this month's cover and in Fig. 16, are representative of latest developments in this field.

Curing time for resins is being reduced steadily. Polyesters with a cure cycle of less than one minute are now in evaluation stages. Alkyds cure rapidly. Depending upon section thickness, cure time may be in the order of a few seconds. With thermoplastic resins, considerable improvement can be made by slight modifications in formulation. However, these may affect other characteristics so a compromise usually must be made between molding characteristics and physical properties.

The parts shown in Fig. 17 illustrate how one-piece plastic moldings can replace multi-part metal assemblies when the production volume merits the die investment. Noteworthy design features include molded counterbores, rib-



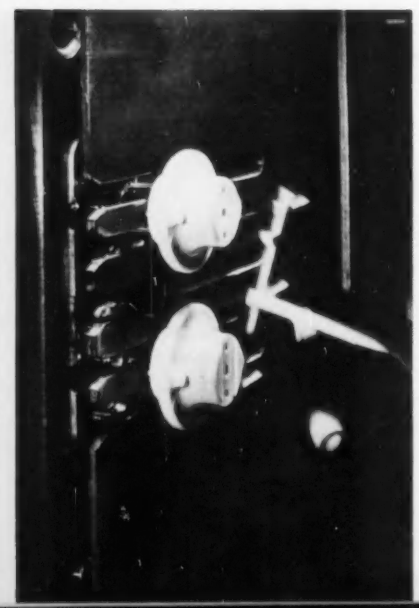


Fig. 16—Two steps in cycle of automatic injection molding machine. At left, parts and runner are positively ejected by hydraulically operated embedded knockout pins. Note that die has five cavities—two large pieces and three small ones are molded simultaneously. Gates are cut from parts during the ejection stroke. Parts remain in the fully ejected position as comb moves across the mold face, right. Comb supports parts while sprue is cut by knife cammed on to face of stationary mold. F. J. STOKES MACHINE CO.

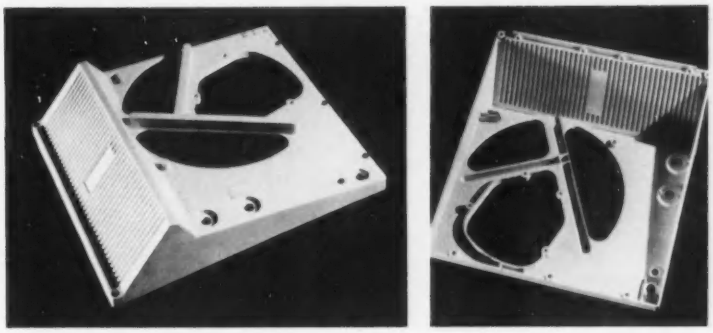


Fig. 17—Injection molded polystyrene motor board for phonograph is example of complex shapes that can be produced to replace multiple assembly of metal parts. Molding requires no finishing except for trimming gates. Multi-functions performed by this part include: (a) support motor and turntable, tone arm and two loud speakers; (b) decorative loud speaker baffle; (c) built-in tone arm rest; and (d) built-in electric plug holder. Two large counterbored holes are molded as shown to make it possible to hold chassis in place with speed nuts on volume control and tone control potentiometers; no screw fasteners are needed. Underside view shows how ribbing is used to increase rigidity of thin-walled part. STEELMAN PHONOGRAPH AND RADIO CO., INC.

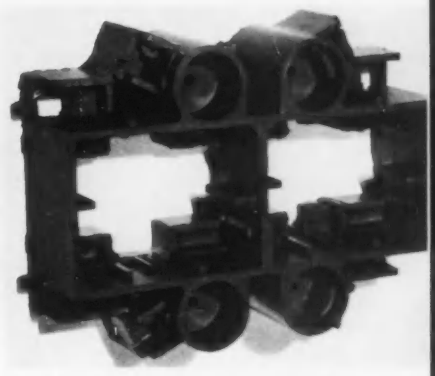


Fig. 18 — Complex electrical component produced of thermosetting material by transfer molding because undercuts could not be compression molded. Excellent mechanical and electrical properties make thermosetting materials ideal for such components. GENERAL ELECTRIC CO.

bing for added rigidity, multiple holes at different angles and planes.

If undercuts are required with thermosetting materials, transfer molding is more efficient than compression molding, particularly when thin cross sections are involved, or for parts subject to breakage from strains imposed during mold fill-out, as in the example shown in Fig. 18.

Transfer molding, Fig. 19 is defined as the forming of articles in closed mold that is conveyed under pressure in a hot plastic state from an auxiliary chamber. It is roughly analogous to injection molding of thermoplastics.

Transition molding recently developed at Northrop Aircraft, can be used to produce complex grills, such as the one illustrated in Fig. 20, from thermosetting materials.

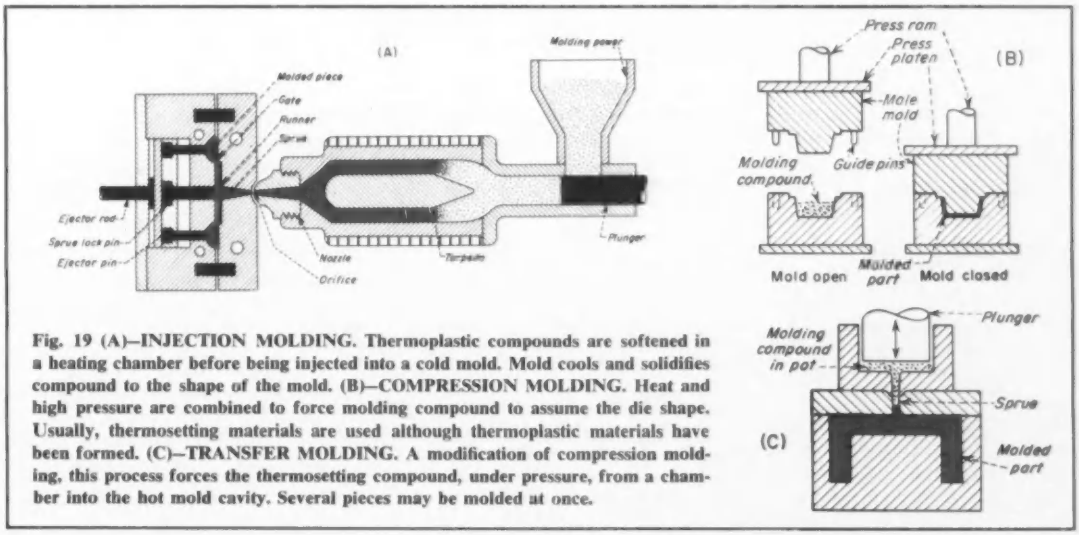


Fig. 19 (A)—INJECTION MOLDING. Thermoplastic compounds are softened in a heating chamber before being injected into a cold mold. Mold cools and solidifies compound to the shape of the mold. (B)—COMPRESSION MOLDING. Heat and high pressure are combined to force molding compound to assume the die shape. Usually, thermosetting materials are used although thermoplastic materials have been formed. (C)—TRANSFER MOLDING. A modification of compression molding, this process forces the thermosetting compound, under pressure, from a chamber into the hot mold cavity. Several pieces may be molded at once.

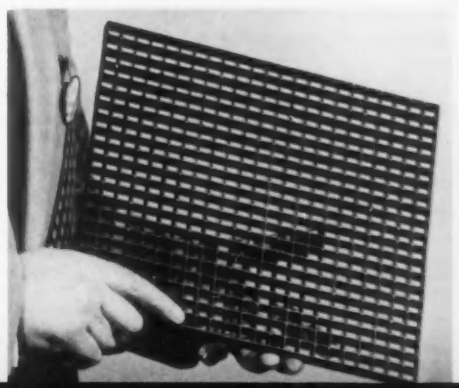


Fig. 20—Complex grid produced by new transition molding process developed at Northrop Aircraft, Inc. It is made of epoxy resin by a three-stage molding process. Cost of parts made in this manner is only four per cent of the cost of producing machined aluminum parts of the same type. Original female mold is milled from a block of Cerrobend, an epoxy master is cast in this mold and removed by melting the alloy. Elastomer is then poured around the master part to produce a flexible mold. Parts can be cast, regardless of draft angles or undercuts to a tolerance of plus or minus 0.002 in.

Vacuum Forming

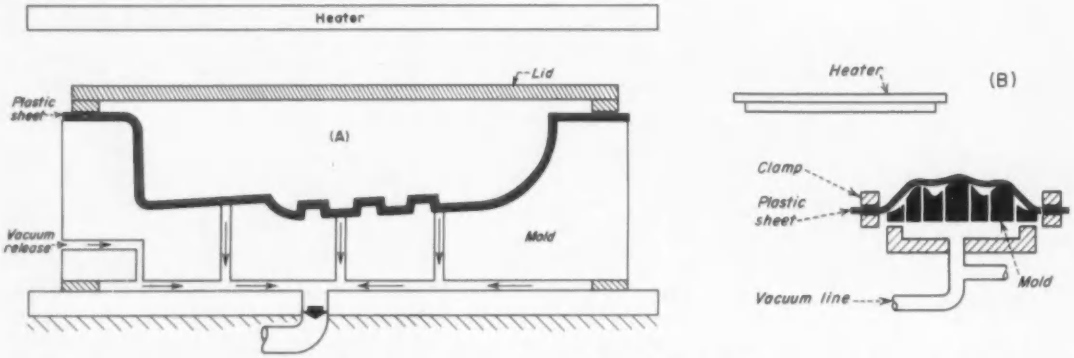


Fig. 21—In straight vacuum forming, left, a heat-softened rigid or flexible thermoplastic sheet is pressed into or onto a mold by atmospheric pressure upon evacuation of the air beneath the sheet. The process originally utilized a female mold, although a recent refinement of the method, referred to as drape forming, right, makes it possible to obtain more uniform wall thicknesses in the finished piece and to produce deeper draws. By comparison, drape forming provides for the stretching of a heat-softened thermoplastic sheet over a male mold prior to the drawing of a vacuum.

VACUUM FORMING is a method of using partial atmospheric pressure to force a sheet of hot, flexible thermoplastic material into conformity with a mold. There are several variations of the process and many materials which can be used include flexible and rigid vinyls, styrenes and polystyrenes, polyethylenes, cellulose acetate, and cellulose acetate butyrate.

In straight or female forming, Fig. 21 (A), the sheet is clamped on the mold or box that surrounds the mold, heated until it becomes flexible and then is drawn into the cavities by reducing the air pressure on the under side of the sheet. With parts having relatively shallow draws, this method gives good results. However, with deep draws or parts having small radii, corners and bottoms are thinned.

Drape forming, Fig. 21 (B), differs from straight vacuum forming in that the sheet is held in a frame above a male mold. After it has been softened, the sheet is stretched down over the mold. This results in more uniform wall thicknesses and makes possible deeper draws than are practical with straight vacuum forming.

A combination and modification of both straight vacuum and drape forming, called plug-assist forming, offers another means of extending the range of the vacuum forming process. A conventional straight forming, or combination male-female mold is used. The plug, which is roughly the shape of the cavity, forces the softened sheet down and prestretches it somewhat as in drape forming. The sheet is removed by vacuum as soon as the plug bottoms, and is stretched further to reproduce the mold surface detail. Advantage: Parts too deep for either vacuum or drape forming can be produced with relatively little thinning. Prime disadvantage is added equipment necessary.

Costs

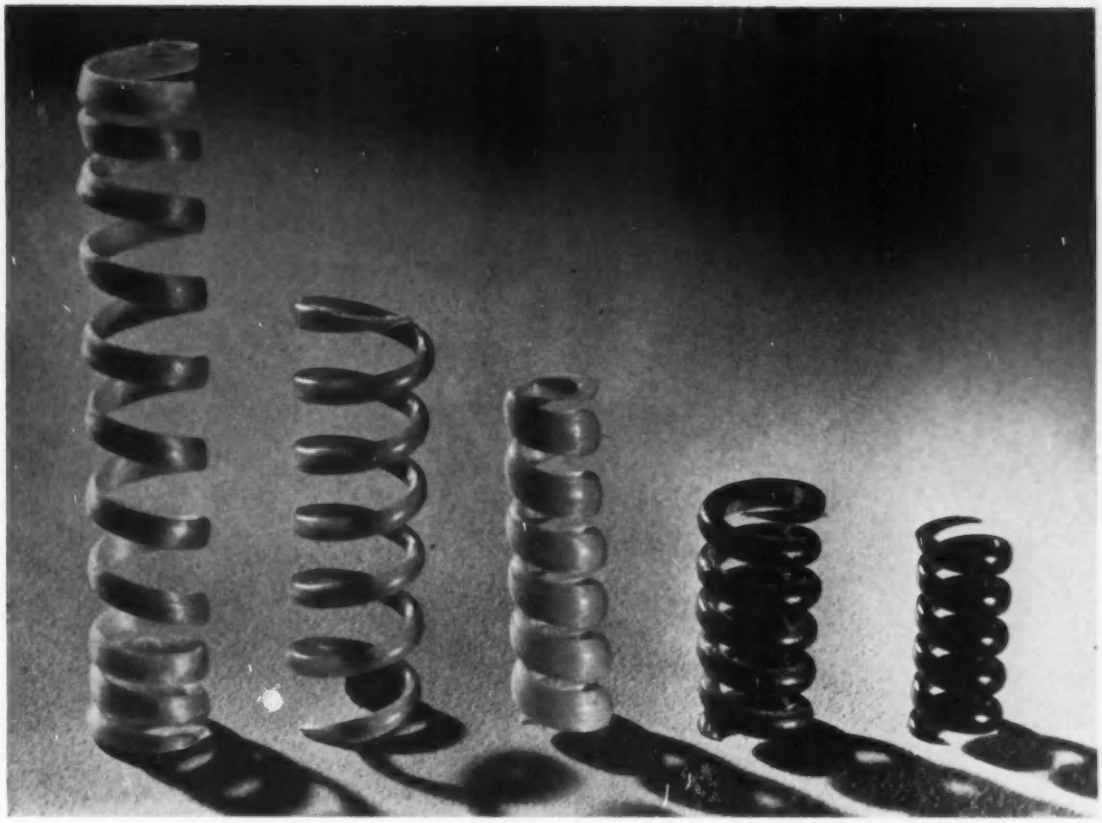
TO ESTIMATE THE COST of producing a part in plastic, the density as well as the cost per pound of resin must be considered. Thus, polyethylene, which is the lightest of all plastic materials (specific gravity 0.92-0.93) often compares favorably with less expensive resins when cost per piece is computed. Similarly, polystyrenes are attractive price wise. Phenolics are the lowest price of all resins per pound. Table XIV compares prices of several plastic materials both on a weight and volume basis.

Other factors to consider when estimating the costs are the cycle time and tooling costs. Special colors need not be more expensive than standard shades if volume is such that orders can be made in large quantities.

Table XIV — Typical Prices of Molding Compounds

These prices are based on latest data and are intended for comparison purposes only. For each material listed a range of prices exists depending upon supplier, modifications in formulation, special fillers and additives, etc.

Material	Price $/lb	Density lb/cu. in.	Price $/cu. in.
Acrylic			
colorless	0.60	0.426	0.26
colors	0.63	0.426	0.27
Alkyd	0.45	0.686	0.31
Cellulose Acetate	0.48	0.451	0.22
Cellulose Acetate Butyrate	0.65	0.397	0.26
Epoxy	0.75	0.400	0.30
Fluorocarbon	9.00	0.760	6.84
Melamine	0.52	0.534	0.28
Nylon	1.35	0.394	0.53
Phenolic	0.15	0.452	0.07
Glass filled	0.20	0.633	0.12
Polyester	0.35	0.435	0.15
Polyethylene	0.41	0.332	0.13
Silicone	2.75	0.579	1.60
Styrene, general purpose	0.30	0.380	0.11
Special high impact types	0.50-0.65	0.380	0.19-0.25
Urea	0.33	0.542	0.18
Vinyl	0.27	0.488	0.13



Plastic Springs

Methods of manufacture developed at the National Bureau of Standards for helical compression springs designed to operate at 135 F; torsional elastic properties of resins and effect of glass reinforcement; performance of springs made from an epoxy-glass material.

FRANK W. REINHART and SANFORD B. NEWMAN
National Bureau of Standards

SPRINGS ARE USUALLY made of metal, but some plastic materials can be used to advantage for special purposes: They are non-magnetic, have low electrical and thermal conductivity, and have high resistance to corrosion. The strength-to-weight ratio is often higher than for metal springs, and the range of transparent and colored materials offers decorative effects.

While plastic or other non-metallics can be formed into any of the usual spring shapes, the work done with plastic springs at the National Bureau of Standards deals with helical compression springs. Some consideration also has been given to the development of block compression springs for use with higher loads.

Forming methods for metal springs usually produce considerable residual stress in the finished product. Plastic springs, however, may be molded directly to dimension without developing internal stresses. While the physical properties of both plastics and metals depend on time and temperature, plastics are much more sensitive than the metals commonly used in springs.

Fig. (1A)

Fig. (1B)

For a specific spring application, a plastic spring was needed that could be easily fabricated by mass production methods, and useful at air temperatures from −40 F to +135 F. The spring had to be no larger than 2 in. in dia., 3 in. long, and support a load of 25 lb. at a deflection of 0.25 to 0.50 inch. Upon release of the load, it had to produce approximately 30 in.-oz. of kinetic energy.

Forming Methods

Several springs were manufactured by turning tubes of polystyrene, cellulose nitrate, and paper-filled phenolic on a screw cutting lathe. The lathe tool cut through the wall until only a spiral of the plastic remained. While it produced springs, this technique was not a mass production method. In addition, the final dimensions of the spirals were influenced by residual stresses in the tubes.

Springs also were made by wrapping resin-soaked glass fiber braid or glass fiber rovings around mandrels and curing the resin in place. However, this method appeared to have limited usefulness.

The most successful procedure, see Figs. 1A, B, C, was found to be the polymerization of a resin composition in a tube of vinyl-chloride vinyl-acetate copolymer. Lengths of glass rovings were formed into a loose, untwisted yarn, and doubled to form a U-shaped bundle. This bundle was placed in a trough partly filled with liquid resin and immersed until it was thoroughly soaked. A steel wire was threaded through a length of vinyl tubing with an inside diameter of $\frac{1}{4}$ or $\frac{5}{16}$ in., and a wall thickness of $\frac{1}{8}$ inch. The end of the wire was attached to the loop in the bundle of resin-soaked rovings and the impregnated filaments drawn into the tubing. When the tubing was completely filled, the wire was removed and the ends of the tubing sealed with hose clamps.

The sealed tubing was wound in a helix on a mandrel of the desired diameter, and the tubing ends were restrained just sufficiently to hold the spiral in position. Curing was carried out under the conditions specified by the resin manufacturer in an air-circulating oven. After removal from the oven, the springs were cooled and the tubing removed. Post curing was performed when required.

Finally, the springs were cut and ground to the finished length. Some batches of the vinyl tubing adhered to or fused with the resins used in forming the springs. This was prevented by first heating the tubing at 250 F for 2 hr, or until it began to discolor.

Spring Properties of Resins

To select the most promising resins, the torsional modulus was measured on specimens in the form of a 14 in. rod, using an active rod length of 10 in. in the test. Fig. 2. Static load tests were made at room temperature (73 F), at 173 F in a circulating air oven, and in a cold box at −40 F.

Each specimen was prepared using catalysts, curing agents, and polymerizing conditions recommended by the resin suppliers. Curing time for epoxy resins ranged from 3 hr at 167 F to 15 hr at 135 F, with post cure from

Fig. 1—First stage of plastic spring manufacture (A) consists of soaking the glass fiber rope in the plastic solution. A piece of piano wire tied to one end of the glass fiber rope is run through a section of plastic tubing at left. (B)—The plastic soaked glass fiber rope is next drawn into vinyl tubing of about 1/4 or 3/16 in. ID, and a 1/8 in. wall thickness. As the rope is drawn up into the tubing, the excess plastic solution is squeezed off. Wire is then removed and the tube ends sealed off. (C)—Sealed tubing is next wound around a mandrel to form a spring. Entire assembly is placed in an oven for curing, with time and temperature determined by the type of plastic used. After the curing period, the tubing is removed from the spring. The most promising resins used were epoxides and polyesters.

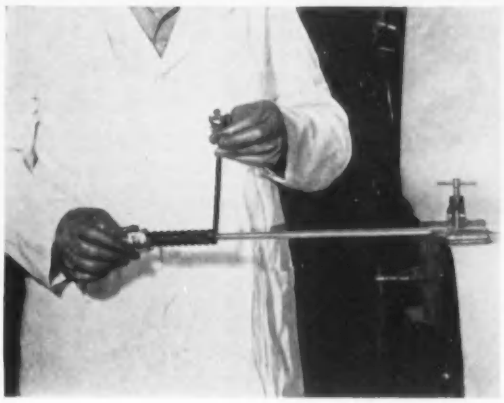


Fig. (1C)

Fig. 2—Test stand used for measuring torsional modulus of cured plastic rod used for springs. Length of rod is about 14 inches.

Table I—Torsional Modulus of Plastic Rod Specimens

Resin	NBS Composition No.	Modulus × 1000 psi at temperatures of		
		73 F	*135 F*	*−40 F*
Polyester	3	163	102	314
	2	164	106	348
	7	203	70	465
	6	249	99	376
	12	248	115	498
	11	251	137	413
	9	252	162	435
	18	312	110	425
	17	334	195	457
	22	346	147	442
	15	352	122	450
Epoxy	29	147	150*	311
	28	212	183	332
	27	220	270*	352
	26	232	239*	375
	24	244	206	351
	23	264	211	378

* — referred to in text

none to 48 hr at 212 F, and 4 hr at 302 F. For polyesters, the cure time ranged from 4 hr at 73 F to 1 hr at 158 F, and post cure from none to 1 hr at 183 F.

Glass roving with a chrome finish was used in most of the specimens. Braided and ribbon tape were also tried, as well as nylon filament.

Variation of torsional modulus with temperature was found to be primarily a function of the resin, and within limits independent of the amount of glass reinforcement. The change in modulus with temperature for a typical group of specimens is shown in Table I. Note that the modulus apparently increased with temperature in some instances indicating continued cure of the resin at the elevated test temperature. For several specimens, the modulus at elevated temperature was too low to make further tests of any value.

The most promising resins were epoxides and polyesters, with the epoxy resins generally less sensitive to temperature. The epoxy resins varied but were little affected by the amount of curing agent. Plasticizers were found to increase the permanent set at elevated temperature. Each resin requires tests to determine the best conditions.

Torsional modulus values for several other types of resins were recently reported for a moderate range above room temperature. As summarized in Table II, only polystyrene approached the better epoxy and polyester resins in the NBS tests.

Effect of Glass Reinforcement

One of the best materials examined in the NBS tests was an epoxy with 15 per cent m-phenylene diamine (composition no. 23, last in Table I). The resin was polymerized (B stage) in 3 hr at 158 F, removed from the vinyl tubing, and cured for 64 hr at 140 with 10 hr post cure

at 300 F. Nonreinforced rods had a modulus of about 250,000 psi. With five double rovings of glass (600 ends), the modulus of a helical spring showed a four-fold increase to 1.0 x 10^6 psi. including Wahl correction factor.

Properties of Experimental Springs

More than a hundred of the springs have been made. Under a 25 lb load the average deflection is 0.53 in. with a standard deviation of 0.05 in., showing that a high degree of uniformity in static properties is possible.

Springs were compressed to their solid lengths and held for a minimum of 13 days at 135 F. The force required to compress them, and the recoverable energy before and after storage at elevated temperature is given in Table III. Test results on No. 10, an epoxy resin (composition 23), showed that the space and load requirements initially set up (3 in. free length, 1 in. O D, 5 in.-lb energy) could be met after being held at solid length for 13 days at 135 F. Since the energy decay curve of a helical spring is exponential, the greatest loss of energy occurs during the first few days. After 30 days, a residual energy of over 30 per cent would appear possible.

Upon retesting glass-epoxy springs, it was found that the second test invariably resulted in higher recoverable energy than the first, as shown in Table IV. This "work tempering" was substantiated by torsion tests on nonreinforced plastic rods. As much as 120 per cent of the original available energy is obtained. Preloading the epoxide spring during storage, or within thirty days before use, would make it possible to utilize this property.

Glass roving reinforcement increased the potential energy capacity of the springs, but it did not increase the proportion of energy recovered after being held in the compressed state at elevated temperature. Creep at elevated temperature is a function of the deformation or stress rather than the applied force.

Glass roving was introduced so that torsion of the rod would produce stress in the glass by braiding or producing knots in the glass fiber. Although this caused local variations and irregularities in the spring density, the gain in energy recovery more than compensated for any loss in the maximum spring strength. A 7 per cent increase in energy recovery appeared to be attributable to this change in the form of the glass roving. There was no comparable improvement in spring properties as a result of varying the finish on the rovings.

Both springs and rods showed little variation from end to end in glass-resin content. Springs with a uniform and selected composition can be easily produced. Examination of the cross section of the finished springs shows a concentration of glass reinforcing toward the inner periphery of the section. This can be minimized by first subjecting the filled tubing to an opposing twist when wrapping it around the mandrel before curing.

Properties of plastic springs can be varied widely. For example, stiffer and probably more brittle springs result when the glass content is increased. The number of coils per unit length may be decreased when using tubing of greater wall thickness, and dimensions may be varied as required by other applications. Where the temperature range is limited, other resins such as the polyesters may be economically substituted.

Table II—Torsional Modulus of Plastic Materials

Material	Modulus × 1000 psi at temperatures of		
	86 F	*122 F*	*158 F*
Polystyrene	190	166	137
Cellulose Acetate	63.4	35.4	18.6
Cellulose Acetate Butyrate	63.4	37.3	21.3
Polymethyl Methacrylate	159	117	83
Phenolic-wood Floor	345		

Note: Data from Sharpe and Maxwell "Torsional Properties of Plastics," *MODERN PLASTICS*, Dec. 1955, p. 137

Table III—Energy Recovery of Some Plastic Springs

NBS Spring Number	Initial Force, lb	Initial Energy, in.-lb	After 13 days at 135 F Force, lb	After 13 days at 135 F Energy,[a] in.-lb	Energy Available, per cent
1	28.2	11.0	14.9	3.64	33.0
2	21.9	6.35	13.6	1.43	22.5
3	36.2	9.2	23.2	4.17	45.0
4	36.1	5.6	25.4	2.67	48.0
5	40.1	12.33	11.0	0.88	7.1
6	42.2	15.82	14.7	1.10	7.0
7	43.9	12.75	24.6	1.72	13.5
8	43.4	11.72	14.4	1.08	9.2
9	43.3	15.2	23.4	3.74	24.6
10	40.7	12.3	37.4	5.24	42.6

[a] — In.-lb available in static load measurements after being compressed to solid length for a minimum of 13 days at 135 F

Table IV—Results of "Work Tempering" Epoxy-Glass Springs

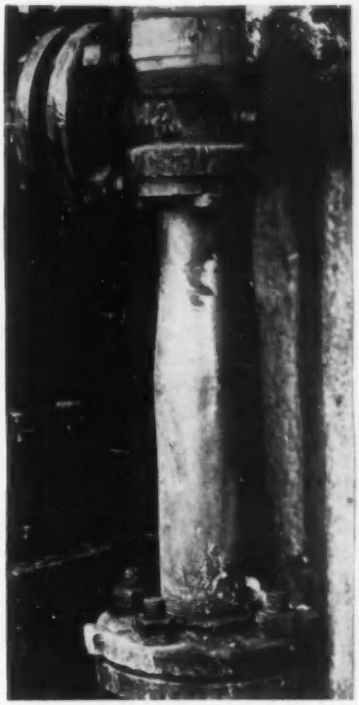
NBS Spring Number	Test	Period Between Test 1 and Test 2, days	Initial Energy, in.-lb	After 13 days at 135 F in.-lb	Energy Available, per cent
1	1	..	7.8	1.43	18.3
	2	45	11.0	3.64	33.0
3	1	—	15.0	3.08	20.6
	2	14	9.2	4.17	45.0
4	1	—	6.85	1.51	22.0
	2	7	5.6	2.67	48.0

EDITOR'S NOTE: Based on a paper presented at the 1956 Annual Meeting of The Society of the Plastics Industry. The authors acknowledge assistance in this project from Thomas E. Bartlett, R. G. Thresher, Joseph Messineo, and Thomas B. Blevins, of the Army Ordnance Corps, and Murray C. Slone, Desmond A. George, Leon Horn, George G. Richey, Catherine B. Simpson, and George S. Saines, of the National Bureau of Standards.

Corrosion Resistance of Titaniuun

ANDREW N. ESHMAN
Service Engineer, Mallory-Sharon Titanium Corporation, Niles, Ohio

Resistance to galvanic, marine, and chemical attack; comparison with stainless and aluminum for a wide range of chemicals.



TAPERED DIFFUSER made of titanium replaced cast iron which failed every three months. Titanium diffuser is still in service after 1½ years exposure to hydrochloric acid and high velocity steam. Note corrosion on cast iron flange. Courtesy E. I. Du Pont de Nemours & Co., Inc.

IN MANY APPLICATIONS titanium offers the lowest lifetime cost of any material. In airframe and jet engine applications, titanium's lightness, high strength at elevated temperatures, and corrosion resistance provide a vital edge in aircraft performance. However, in commercial and industrial applications the exceptional corrosion resistance of titanium is its key advantage in chemical and food processing equipment, refining, mining, and other processes where long corrosion life is imperative.

Titanium is uniquely superior in resisting corrosion by nitric acid, moist chlorine, solutions of chlorine, chlorinated organic compounds, and inorganic chloride solutions. Its excellent resistance to corrosive attack in sea water and in most chloride salt solutions is unchalllenged by other structural metals.

The nature of this corrosion resistance is presumably due to a thin protective oxide film formed when exposed to air. This passive surface film is evidently more stable than films on other passive metals as it is not even destroyed by such vicious corrodents as ferric or cupric chloride.

Additional advantages of titanium over most metals are its resistance to stress corrosion and to pitting attack in a solution where corrosion does take place. Further, the corrosion resistance of a titanium weldment is essentially the same as that of the parent metal, which is not true for unstabilized stainless steels. Corrosion resistance of titanium alloy materials, in most cases, is essentially the same as for the commercially pure grade. However, while laboratory tests are indicative of behavior, definite answers can best be obtained by tests under actual conditions.

Galvanic Corrosion

In the galvanic series shown in Table I, titanium like Monel metal and passivated stainless steel, is one of the least corrodible metals or alloys. Many factors, such as depolarization and destruction of the passive film, can change the position of the metal in the series.

Aluminum or magnesium when coupled to titanium in the presence of a suitable electrolyte such as sea water suffer accelerated corrosion. Salt spray tests conducted in the Naval Aeronautical Material Laboratory in aerated sodium chloride solutions have indicated a penetration of 33 milligrams per year for 7075 S aluminum and 1240 milligrams per year for magnesium. In aircraft assemblies where mating parts of aluminum and titanium are joined, standard practice is to give the mating areas a primer coat of paint.

Environmental Effects

There is no significant corrosive attack on titanium when exposed to marine and urban atmospheres, salt water spray, brackish river water, or in low or high velocity sea water. Fouling organisms which accelerate corrosion on other passive metals have no effect on titanium. Tests were conducted by the U. S. Navy on titanium panels subjected to sea water at a velocity of 24 to 30 feet per second for two months with no adverse effects.

Resistance to Chemicals

Titanium exhibits resistance to corrosive attack by many inorganic and organic chemicals. It has high resistance to attack by hot chloride solutions which severely attack most metals. In combinations of acids that do attack titanium the addition of even small amounts of an oxidizing acid such as nitric or salts such as copper sulfate reduces corrosive activity. Table II lists various corrosive media and shows the behavior of titanium, 18-8 stainless steel, and aluminum. These ratings are a means of evaluating corrosion resistance as outlined in Uhlig's Corrosion Handbook. Generally Class A materials are suitable for use where

Advantages of Titanium for Industrial Applications

Strength and lightness: In yield strength and ultimate strength, some titanium alloys are equal or superior to many alloy and stainless steels, while weighing only 56 per cent as much. On a strength-to-weight basis, titanium alloys are superior to 18-8 stainless steel up to 900 F, and to aluminum alloys above 250 F.

High temperature performance: Titanium alloys are satisfactory for continuous service operating temperatures up to 800 F, and for brief periods up to 2000 F. Other light metals lose strength rapidly above 250 F.

Corrosion resistance: Titanium exhibits excellent resistance to corrosion; is immune to salt water, marine atmospheres, and to many acids, alkalis and other chemicals.

Erosion resistance: Titanium has exceptional resistance to erosion, cavitation and impingement attack.

FORGED FEMORAL PROTHESIS of titanium for implanting in the hip joint to fix a fracture. Titanium plates and screws for surgical implants have also been produced. In addition to superior corrosion resistance and lightness titanium seems more compatible with tissues and bones.

Table I—Galvanic Series of Common Metals

(Corroded end, anodic or least noble)

Magnesium
Magnesium Alloys
Zinc
Galvanized Steel
Aluminum-52SH
Aluminum-2S
Alclad
Cadmium
Aluminum 24S
Mild Steel
Wrought Iron
Cast Iron
Ni-Resist
Type 410—Stainless Steel
50-50 Lead Tin Solder
Type 304 Stainless Steel (Active)
Type 316 Stainless Steel (Active)
Lead
Tin
Muntz Metal
Manganese Bronze
Naval Brass
Nickel (Active)
Inconel (Active)
Yellow Brass
Admiralty Brass
Aluminum Bronze
Red Brass
Copper
Silicon Bronze
70% Cu-30% Ni
Composition G-bronze
Composition M-bronze
Nickel (Passive)
Inconel (Passive)
TITANIUM
Monel
Type 304 Stainless Steel (Passive)
Type 316 Stainless Steel (Passive)

(Protected end, cathodic or most noble)

little dimensional change can be tolerated. Class B materials can be used when some corrosion is permissible with a subsequent dimensional change. Class C ratings indicate that the material is not considered suitable for use because of excessive corrosive attack.

NOTE: Caution should be exercised when titanium and titanium alloys are in contact with red fuming nitric acid. Under certain conditions explosions have been reported that have not been fully explained. For further information refer to Progress Report #Z6-1—dated September 30, 1955—Contract #AF33 (616)-3066 "Corrosion and Ignition of Titanium Alloys in Fuming Nitric Acid" prepared by Jet Propulsion Laboratory, California Institute of Technology, Pasadena 3, California.

EDITOR'S NOTE: A literature survey of "Titanium Bolts and Fasteners" appeared in the *Product Design Handbook Issue* for 1956 page G-12. Included are the results of tests to compare properties of titanium with those of steel, stainless steel, and aluminum. Effects of cold working on titanium are described and design recommendations cover selections of alloy for corrosion resistance, weight saving and fatigue.

A more detailed discussion of the "Strength of Titanium Bolts," by Joseph Viglione, *Product Engineering*, April 1955 page 129, covers ultimate tensile strength, fatigue strength and ductility. An earlier study by the same author, "Strength of Titanium Spotwelded Joints," July 1954 page 193, described a program set up to establish design recommendations for the selection of material for spotweld application.

"Titanium Forgings," by E. A. Fentzlaff, Dec. 1954 page 129, covers the close working arrangement required between designer, supplier of titanium ingot and forge operator to select the most suitable material and process for the end use.

Table II — Resistance to Chemicals

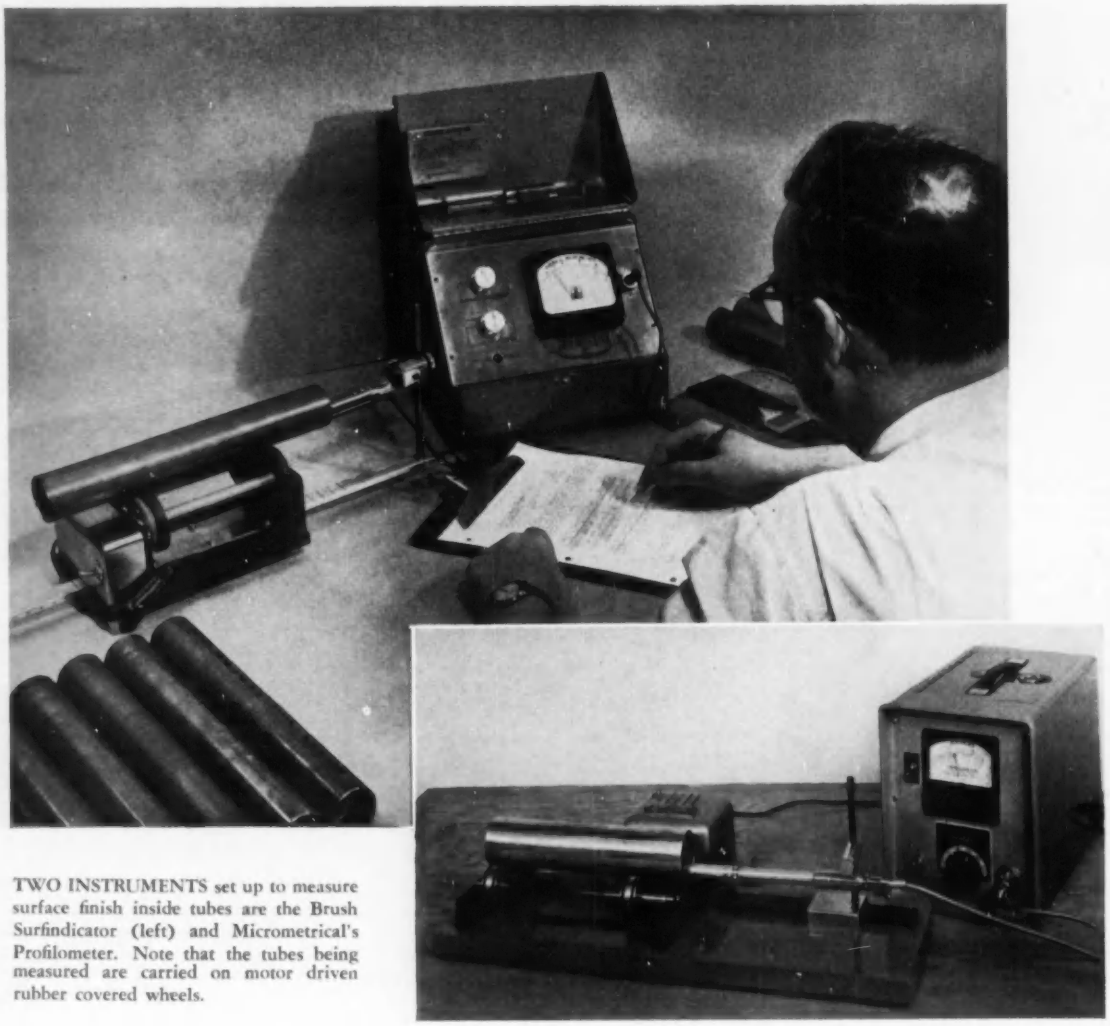
Data from Pigments Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

Rating	*Degree of Attack, in. per yr*
A	Less than 0.005 in.
B	Between 0.005 and 0.050 in.
C	More than 0.050 in.

* Caution; see text

CORROSIVE MEDIA			CORROSION RATING			CORROSIVE MEDIA			CORROSION RATING		
Reagent	Concentration Percent	Temp. deg F	Titanium	18-8 Stainless	Aluminum	Reagent	Concentration Percent	Temp. deg F	Titanium	18-8 Stainless	Aluminum
Acetic Acid—Glacial	99	B.P. 246	A	B	C	Nitric Acid, aerated	5 to 20	95	A	A	C
Acetic Anhydride	99	68	A	A	A		5 to 60	212	A	A-C	C
Aqua Regia (3 HCl-1 HNO_3 or 1 HCl-3 HNO_3)	...	Room	A				20	554	B		C
Aluminum Chloride	25	140	A	C	C		40	392	B	C	C
Aluminum Chloride	25	212	C	C	C		65	347	A	C	C
Ammonia 20% + Sodium Hydroxide 2% + Water	...	...	A				70	518	B	C	C
Ammonium Chloride	Sat.	212	A	C	C		65	Boiling	A	C	C
Ammonium Hydroxide	28	Room	A	A	A		98	Room	A	B	A
Aniline 98% + Aluminum Chloride 2%	...	316	C			Nitric Acid, unaerated	Red Fuming	Room	A*		
Aniline Hydrocloride	20	212	A	Rapid	C			122	A*		
Barium Chloride	20	212	A	B				158	A*		
Bromine	Liq.	86	Rapid	Rapid	C		White Fuming	Room	A		
Bromine	Vapor	86	A					252	A		
Citric Acid	50	212	A	C	B			320	A		
Calcium Chloride	28	Boiling	A	B		Nitric Paranitrotoluene	20-25	356	A		
Calcium Hypochlorite	6	95	A	B		Oxalic Acid	1	99	B	A	C
Carbon Tetrachloride + 1% water	100	Boiling	A			Phosphoric Acid	10	176	C	C	C
Chloroacetic Acid	30	176	A	C	C		85	Room	B	C	C
Chloroacetic Acid	100	Boiling	A	C	C	Photographic emulsions	...	...	A		
Chlorine Gas, water saturated	100	167	A	C		Sea Water, Kure Beach	...	Ambient	A		A
Chlorine Water, Cl_2 saturated	...	167	A	C		Sodium Chloride	Sat.	Boiling	A	C	
Chlorine Water and HCl		41-77	A			Sodium Hydroxide	10	Boiling	A	B	C
Chromic Acid	10	Boiling	A	C			28	Room	A	B	C
Cupric Chloride	40	Boiling	A	C	C		40	176	B	B	C
Dichloro Acetic Acid	100	212	A			Sodium Hypochlorite	5-6Cl_2	Room	A	C	
Ethyl Alcohol	95	Boiling	A			Sodium Sulfide	10	Boiling	A	B	
Formic Acid (H_2) solution + traces of cyclohexane	9	104-122	A			Silver Bromide, suspended in a gel	...	...	A	B	
Ferric chloride	10	Boiling	A	C	C	Silver Bromide + 2% silver iodide	...	...	A		
Formaldehyde	37	Boiling	A	A	A	Stannic Chloride	24	140	A	C	
Formic Acid	50	Room	A-C	A	Rapid	Stearic Acid	100	356	A	A	
Aerated	90	212	A	C	C	Sulfur, molten	100	464	A	A	
Hydrogen Peroxide, C.P.	30	Room	B			Sulfur plus Water	...	Room	A		
A.C.S.	30	Room	A			Sulfur Dioxide, water saturated	...	Room	A		
Hydroxyacetic Acid	...	104	A			Sulfuric Acid	1	Room	A	B	B
Hydrogen sulfide saturated water	...	Room	A	B	A		1	Boiling	C	C	C
Hydrochloric Acid, aerated	0.5	95	A	C	B		3	95	A	B	B
	1, 3	140	A	C	C		5	Room	A-B	B	B
	1	212	B	C	C		5	Boiling	C	C	C
	2, 3	212	C	C	C		10	Room	B	C	C
	4, 5	140	B	C	C		10	122	C	C	C
	5	Room	A	C	C	Sulfuric Acid, aerated	40 to 100	Room	C		
	7.5, 10	95	B	C	C		10 to 50	95	C		
	15	95	C	C	C		65, 75	95	B		
	37	95	C	C	C	Sulfuric Acid + H_2 aerated, FeS, & Ti Sulphate	...	...	A		
Hydrochloric Acid 10% + $CuSO_4$ 0.05, 0.10, 0.20%	...	150.8	A			Sulfuric Acid 65% + Nitric 0.70%	...	100.4	A		
Hydrochloric Acid, unaerated	1	95	A			Sulfuric Acid 52% + Nitric 48%	...	Room	A		
	1	Boiling	A-C			Sulfuric Acid 14% + Nitric 83% + H_2O	...	Room	A		
	3	Boiling	C			Sulfuric Acid 65% + $CuSO_4$ 0.05-1.00%	...	100.4	A		
Hydrofluoric Acid	1	Room	C	C	C	Sulfurous Acid	6	Room	A	C	B
Anhydrous	100	Room	B			Tannic Acid	25	212	A		
Lactic Acid	100	Boiling	A	B	C	Tartaric Acid	50	212	A		
Magnesium Chloride	20	212	A	B	C	Trichloroethylene stabilized + 1% H_2O	100	Boiling	A		
Manganous Chloride	20	212	A			Trichloroethylene (unstabilized) + 1% H_2O	100	Boiling	A		
Mercuric Chloride	Sat.	212	A	C	C	Zinc Chloride	20	212	A		
Nickel Chloride	20	212	A		C						

• Suggested procedure for determination of a numerical surface finish



TWO INSTRUMENTS set up to measure surface finish inside tubes are the Brush Surfindicator (left) and Micrometrical's Profilometer. Note that the tubes being measured are carried on motor driven rubber covered wheels.

How to Measure Surface

STEEL TUBING is generally regarded as a structural product. In recent years, however, large amounts of steel tubing are being used for hydraulic cylinders and surface roughness on the interior of tubing has become of increasing importance.

Measurement and evaluation of surface roughness have been under continuing study by a committee of the American Standards Association for the last twenty years. The last edition of the American Standard on designation of surface quality recommends a method of numerical rating of surface roughness and specifications for instrumentation to be used for roughness measurements. Since the standard was designed to cover any type of surface in which the quality of surface finish is important, it was not possible to indicate measurement methods in detail for any given type of surface.

Members of a subcommittee of the AISI, representatives of ASA B-46 committee and of the National Bureau of Standards, working closely with representatives of measuring instrument manufacturers and tubing consumers

SUGGESTED PROCEDURE

for Making Microinch Readings on Interior Surfaces of Cold Worked Tubing (Not Polished or Ground), ½ in. ID and larger

Section 1. Measurements on tubing with longitudinal or no predominate lay should be circumferential on the inside surface of the straight tube, prior to any fabrication, on a plane approximately perpendicular to the tube axis. Measurements on tubing with circumferential lay should be longitudinal.

Section 1–A Measurements should be made not less than 1 in. from end.

Section 1–B Measurements should be made at four positions approximately 90 deg apart or over a complete circumference if the trace should otherwise overlap.

Section 1–C The length of trace should be in accordance with Section 4.5 of ASA Standard B46., latest revision. (Not less than 0.600 in. long).

Section 1–D A minimum of three such measurements should be made spaced not less than ¼ in. apart along the longitudinal axis.

Section 1–E The numerical rating shall be the arithmetical average microinch of all readings taken. Each reading to be averaged should be the mean position of the indicator meter excrusions occupying less than 10 per cent of the total trace should be ignored.

Section 1–F A deviation in numerical rating in various parts of a tube may be expected. Experience to date indicates that a variation of about plus or minus 35 per cent is normal.

Section 2. Instruments should meet the specifications given in ASA Standard B46., latest revision.

Section 3. Mechanical tracing is preferred. If hand tracing is used, the speed of trace should not vary by more than ± 20 per cent from that required to give the appropriate cutoff. The 0.030 in. roughness width cutoff should be used.

Section 4. Microinch determinations only refer to roughness of areas that do not contain a defect, injurious or otherwise. Such defects as seams, silvers, pits, laps, etc., are subject to ordinary visual inspection in accordance with applicable specifications or trade customs and have no relationship to roughness.

Finish Inside Tubes

C. R. LEWIS
Joint Consumers and Producers Committee
Formed Steel Tube Institute

have evolved a draft of a recommended method of measuring interior finishes. This suggested procedure lays down strict requirements as to the number and location of individual readings to obtain an overall rating for the tube. It recognizes that tubing as fabricated may occur in lengths as long as 20 ft and that it is impractical to attempt to obtain finish measurements in the center of a piece of this size. Consequently, if a long tube is cut into smaller lengths during the process of fabrication, finish measurements taken near the ends of the original length will be subject to variation in the shorter pieces. This fact is recognized in the procedure and indication of its magnitude as obtained from preliminary experiments is given.

No attempt is made to establish levels of roughness which can be maintained in production or which may be necessary for a given application of the tubing. It is hoped that as a larger backlog of experience in this field is accumulated, the questions of surface roughness which can be provided and surface roughness necessary for given applications will receive more definite answers.

Designing Screw Machine Parts

EARL A. THEROUX, Machining Department Superintendent, Greist Manufacturing Company

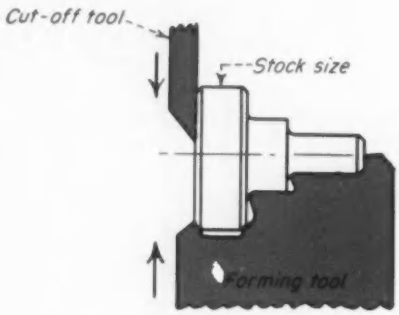


FIG. 1—*Machining of contours* usually performed by cross-feeding a forming tool. Tolerance on diameters depends on initial accuracy of tool ground to correct dimensions and subsequent wear on tool. Tolerance of ± 0.001 in. on diameters can be held—although should not be specified unless necessary. Closer tolerance of ± 0.0005 in. possible but requires more frequent inspection of parts by operator and grinding of tools. Note that sharp edges deburred automatically by contour tool.

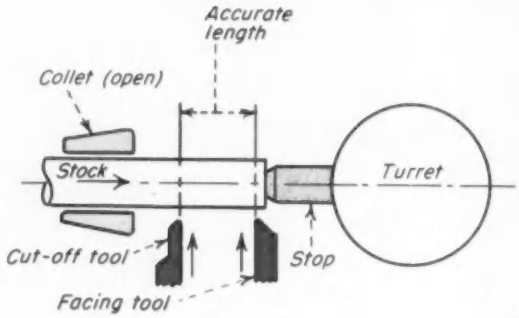


FIG. 2—*Tolerance on over-all length* of ± 0.004 easily obtained when using stop to govern cut-off length. Closer tolerance of ± 0.001 possible by facing-off stock during cut-off. If using forming tool described in Fig. 1 then same tool faces off front of stock.

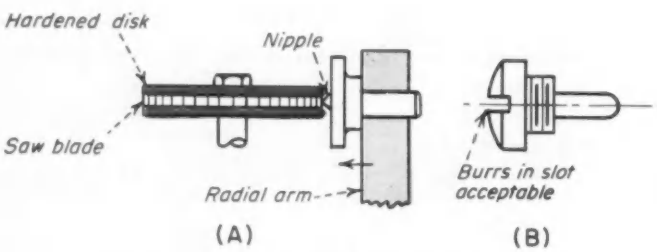


FIG. 5—(A)—*Deburring* back end of piece (usually avoided because may need secondary operation) performed by slotting attachment described in Fig. 4 and two disks on each side of saw. Radial arm picks up part after cut-off and returns to saw position. Saw deburrs nipple left on by cut-off and is prevented from cutting too deeply by disks. (B) If burrs need not be removed then drawing should so specify.

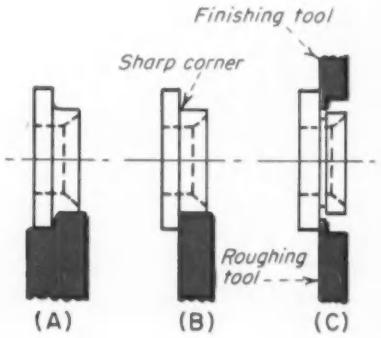


FIG. 6—*Sharp corners* usually require two cutting tools, the first with rounded corner (A) for rough deep cut followed by sharp-cornered tool (B) for finishing cut. This avoids sharp corner on tool (A) from chipping or wearing quickly but increases set-up and machining time. Deep undercut to accurate dimensions (C) also requires roughing tool followed by finishing tool. Very little machining time lost if finishing tool is mounted in reverse on opposite side to operate just behind roughing tool.

Specifying loose tolerances or omitting operations such as burr removal in belief that cost of part is greatly decreased, often leads to substandard products. Quite often, closer tolerances or extra operations only add to the set-up time, which is negligible for long runs.

Data are based on performance that can be expected from well-maintained equipment using a free-machining metal such as listed in Table I.

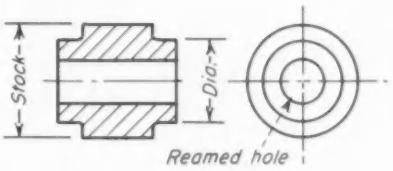


FIG. 3—*Close concentricity* between diameters obtained by proper positioning of tools (spot drill, drill, reamer) in initial set-up. Typical minimum tolerances: 0.002 TIR (total indicator reading) between machined diameters; 0.006 TIR between stock size and machined diameters; ± 0.0005 on reamed holes. Closer tolerance on reamed holes requires accurate grinding of reamer plus frequent gaging of finished parts.

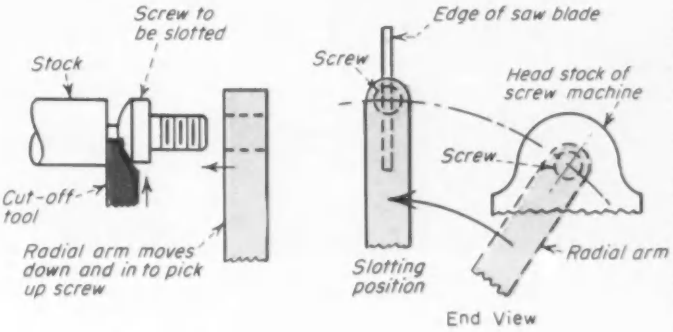


FIG. 4—*Slotting* not a problem with machines having slotting attachment containing radial arm and saw. Arm swings down, picks up part during cut-off, and returns to slotting position. Next piece machined during slotting of first piece. Slots have slight curvature at bottom because of curvature of saw blade. Flat bottom requires special setup.

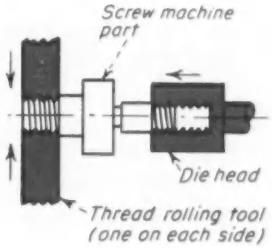


FIG. 7—*External threads* "rolled" on with tool resembling knurling tool, or cut with die head. Avoid specifying threads up to shoulder—leave unthreaded portion of at least twice the pitch of thread. Undercut if mating part must thread to shoulder.

Table I—Recommended Screw Machine Stock

Steel —	C-1117	Nickel	Grade 'A'
Steel —	C-1213	Brass	Free-cutting
Stainless —	303C	Monel	R, KR
Stainless —	416	Aluminum	11ST, 24ST

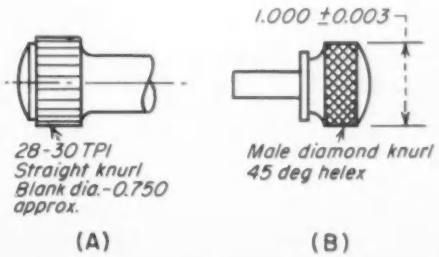


FIG. 8—*Knurling specifications* should be approximate. Diameter after knurling is larger than before knurling therefore specify either as shown in (A) or in (B). Tolerance after knurling can generally be held to ± 0.002 inches. For more details see "How to Specify Precision Knurls," by George Barrow, *Product Engineering*, May 1952 page 142.

SPRAYING A DEEP WELL PUMP ROD with hard facing self-fluxing alloy of nickel-chromium-boron with superior fusing characteristics and wide range of controllable plasticity. Deposit will be fused to provide a hard, dense, corrosion resistant, abrasion protective coating.

Developments in Sprayed Metal Coatings

Advances in the design of powder spray guns now permit economical spraying of metal alloys and ceramic materials. Comparison of guns, discussion of fusing and properties of alloys sprayed by the new equipment.

HERBERT S. INGHAM
Vice President, Engineering
Metallizing Engineering Co., Inc.

Sprayed metal coatings have been in extensive use for over a quarter of a century. Originally sprayed metal was used primarily for repair and maintenance of machines but for many years now new equipment manufacturers have taken advantage of the special properties of sprayed metal and have adopted metal spraying as a manufacturing technique. In the past ten years the variety of machine element applications has grown, largely due to the development of new metallizing equipment and new metallizing alloys. Molybdenum base alloys, for instance, have greatly simplified the process by providing a new method of bonding sprayed metal to base metal, thus eliminating the complicated preparation techniques that had previously been required. Molybdenum base alloys are also proving to be excellent journal materials for use in bearings. New developments in powdered metal spraying equipment and in powdered metal alloys and ceramic spraying materials will undoubtedly extend the use of sprayed coatings. These new coatings have created opportunities for the designer to improve service life, wear resistance, abrasion resistance, and heat resistance of many parts and at the same time reduce their production cost.

SPRAY EQUIPMENT

Until recently there were only two methods in general use for spraying metal and ceramic coatings. In one of these the material to be sprayed is supplied in the form of a wire or a rod which is fed through the gun, melted in an oxygen-gas flame and propelled onto a surface to be coated by a stream of compressed air. This is illustrated in Fig. 1. In the other method, the material to be sprayed is supplied in the form of a powder which is fed through the flame of the gun.

Both of these methods use a fairly large supply of com-

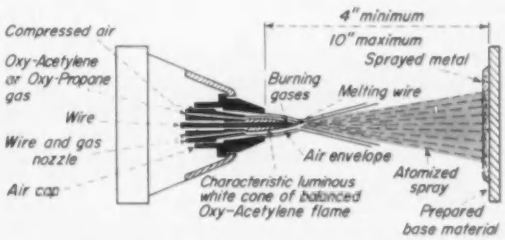


Fig. 1—Standard wire gun in which wire is drawn forward into the gas flame, melted and carried to the work piece by the expanding gases and an air envelope.

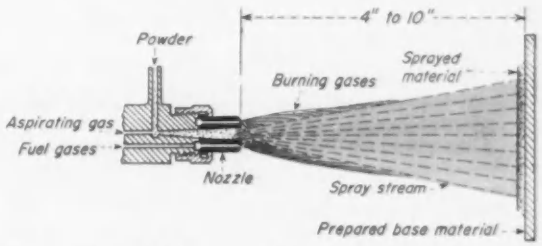


Fig. 2—New powder gun melts and projects coating alloys without the assistance or cooling effect of compressed air envelope.

Table I—Typical Properties of Wire Sprayed Coatings

Sprayed Metal ⅛ Dia. Wire	Consumption per hr.			Covered per. hr. sq. ft. 0.010 in. thick	Deposited per sq. ft. per. 0.010 in. in lbs.	Deposit Efficiency in per cent	Specific gravity	Rockwell hardness	Tensile Strength	
	Acetylene cu. ft.	Oxygen cu. ft.	Metal lbs.						Ult. Str. lbs. per sq. in.	% Increase in length
Aluminum	39	80	17.6	125	130	89	2.41	H 72	19,500	0.23
Aluminum, High Silicon	39	80	19.8	141	130	89	.....	B 80	37,000	0.54
Babbitt, High Tin	37	72	96.3	191	350	69	6.67	H 58	.....	.....
Brass, Yellow	45	97	32	68	388	83	7.44	.....	.....	.....
Bronze, Aluminum	47	97	24	54	340	77	7.06	B 78	29,000	0.46
Bronze, Comm	45	97	24	50	394	82	7.57	B 18	.....	.....
Bronze, M25	45	97	36	75	386	79	7.26	B 27	.....	.....
Bronze, Phosphor	45	97	31	62	398	80	7.68	B 20	18,000	0.35
Bronze, Tobin	45	97	36	73	387	79	7.46	B 27	13,000	0.51
Copper	47	97	29	63	392	85	7.54	B 32	.....	.....
Lead	41	80	147	182	530	65	.....	.....	.....	.....
Monel	39	99	17	34	400	81	7.67	B 39	.....	.....
Nickel	45	97	18	37	393	81	7.55	B 49	.....	.....
Molybdenum—⅛ in.	49	98	5.9	15	344	87	8.86	C 38	7,500	0.30
Stainless Steel 18-8	45	94	21	47	351	79	6.93	B 78	30,000	0.27
Stainless Steel, High Chrome	45	94	19	40	356	75	6.74	C 30	40,000	0.50
Steel 0.10C	36	99	19	46	347	85	6.67	B 89	30,000	0.30
Steel 0.25C	36	99	19	46	348	86	6.78	B 90	34,700	0.46
Steel 0.80C	36	99	19	50	331	88	6.36	C 36	27,500	0.42
Tin	39	72	95	216	340	78	6.43	H 10	.....	.....
Zinc	41	40	61	123	330	73	6.36	H 46	13,000	1.43

pressed air in addition to oxygen and gas. The wire gun can spray any material that can be drawn into a wire or a rod. Some typical metals, their coating properties, and spray speeds are shown in Tables I and II.

Unfortunately many of the very hard materials cannot be drawn into a wire. Such materials have sometimes been bonded together in powder form in a plastic binder to form a wire which can be fed through the gun. Powder guns have sometimes been used to spray these hard materials in powdered form. However, powder guns in the past have had fairly low spraying speeds and wasted a considerable percentage of the metal being sprayed.

A new powder gun has been developed which will spray extremely hard metals, such as the boron-silicon nickel base alloys, and also ceramic materials such as alumina and zirconia. This new gun sprays these materials with deposit efficiencies well above 90 per cent. This high spraying efficiency is very important since most of these hard facing materials are expensive. The new gun has the further advantage that no compressed air is used. It uses only oxygen and acetylene or oxygen and hydrogen depending upon the material to be sprayed. Fig. 2 shows a schematic cross-section of this new gun.

Table II—Rockwell Hardness of Wire Sprayed Metal Coatings

Metal	Coating Hardness	Particle Hardness
Steel 0.10C	B-88 to B-90	C-23
Steel 0.25C	B-95 to B-97	C-34
Steel 0.80C	C-38 to C-40	C-65
Stainless Steel Hi-chrome	C-34 to C-36	C-50
Aluminum Bronze	B-80 to B-82	B-95
Molybdenum	C-37 to C-39	C-60

Table III—Self Fluxing Alloys

(a) A hard-facing material of the chrome, nickel, boron, silicon type, conforming to AMS Spec. #4775. This material has a hardness after fusing of RC 60-64 and must be finished by grinding. Wear and corrosion resistance are excellent. Fusing of coatings over 0.040 in. thick may be difficult, because of high fluidity and narrow plastic range. This alloy is susceptible to cracking when cooling if applied to base metals having a low coefficient of expansion.

Principal Uses: Where thin coatings having high hardness, corrosion resistance, and wear resistance are required. This alloy has excellent wetting properties and is particularly suited for use as a "semi-fused" coating.

(b) A premium hard-facing alloy similar to (a) but modified to lower the fluidity, broaden the plastic range, and lower the coefficient of expansion. Hardness is RC 60-62. Coatings up to 0.080 in. thick may be fused without difficulty, and cracking problems are greatly reduced.

Principal Uses: For general all-around hard-facing use, especially where relatively heavy coatings are needed. This alloy is equal to (a) in hardness and wear-resistance, and has superior corrosion resistance in many environments.

(c) An alloy similar to (b) but soft enough to be machined with carbide tools. Hardness is RC 43-46 and both corrosion and wear resistance are high.

Principal Uses: Where hard coatings having high corrosion and wear resistance are needed, but where finishing must be done by machining. Also used for hard-surfacing alloys such as the straight chrome (400 series) steels, which may give cracking troubles if (a) or (b) are used.

(d) An alloy similar to (c) but readily machinable with ordinary tool steel. Hardness is RC 30-35.

Principal Uses: This alloy exhibits excellent wetting properties and a wide plastic range. It has very good corrosion and wear resistance and is suited to a wide variety of work. It may be applied using hydrogen and a fine grade of powder, to produce very smooth, dense coatings which do not require fusing.

Table IV—Oxidation-Resistant Alloys

(a) A premium stainless steel similar to Type 316. This material has good corrosion resistance and takes a very good finish. Hardness is–RB 80.

Principal Uses: Used for building up worn bronze, stainless steel, or alloy steel parts where a hard coating is not required.

(b) A straight chrome stainless which must be finished by grinding. Not as corrosion-resistant as (a) but has a very low coefficient of expansion and can be applied in any thickness without danger of cracking. Hardness is RC 30.

Principal Uses: Used as a general purpose wear-resistant coating where fusing is not possible.

(c) A chrome-nickel alloy having corrosion and oxidation resistance comparable to Nichrome V, and having excellent machinability. Hardness is RB 90.

Principal Uses: This alloy takes a very fine machine finish, superior to all other cold-sprayed coatings. Bright color matches many alloy steels perfectly. Also used as an oxidation-resistant bond coat for ceramic and cermet coatings.

ALLOYS

Materials suitable for spraying by the new powder gun may be divided into three groups.

1. Self-fluxing alloys, usually (but not always) fused after spraying.
2. Oxidation-resistant alloys, not fused after spraying.
3. Ceramics, such as zirconia and alumina base materials, especially processed and graded for use as abrasion resistant thermal insulators.

In Group 1 the term "self-fluxing" is used to describe alloys to which fluxing agents have been added. The fluxing elements commonly used with nickel base alloys are boron and silicon. The boro-silicate which results from the fusing operation dissolves oxides of iron, nickel, and chromium and promotes wetting and fusing of the metal particles to each other and to the base. The amount of boron and silicon must be carefully controlled in these alloys since their physical properties depend to a critical extent on the boron-silicon content. Alloys of this type range in hardness from RC 30 to RC 65. They possess excellent resistance to corrosion and heat oxidation. They have a very low coefficient of friction and resist wear and abrasion to a much greater extent than most other alloys of equal or greater hardness. A brief description of some of these alloys is included in Table III.

Alloys in Group 2 were developed for use without fusing after deposit. They are designed to resist the formation of oxides without the addition of self-fluxing agents. If metals which do not resist oxidation are used in the powder process, oxides form and are incorporated in the coatings to an objectionable degree. Oxidation resistant alloys of this group include a premium stainless steel somewhat similar to type 316, a high chromium stainless steel, and a chromium nickel alloy which has very high corrosion resistant properties. Some of these alloys are listed in Table IV with a brief description of their properties.

The wire spraying process has a lesser tendency to oxidize the metals than the powder spraying process. For most ordinary work, therefore, the wire spraying process is preferred for use of ordinary metals such as carbon steels, ordinary stainless steels, bronzes, etc. The Group 2 metals discussed above, however, have superior physical properties when sprayed with the new powder gun when using fine powders and hydrogen as a fuel gas. The coatings are finer and denser than can be obtained with the wire process.

Group 3 materials are the ceramics. These have always been the most difficult to spray due to their high melting point and low heat conductivity. When conventional powder guns using compressed air have been used for spraying ceramics the cooling effect of the air has seriously reduced the thermal efficiency with a resulting poor de-

posit efficiency. The new powder gun sprays ceramic materials with a very high deposit efficiency due to its unique design which eliminates the compressed air altogether. With the new gun deposit efficiencies above 90 per cent are common, even when spraying the high melting point materials such as alumina.

There are two ceramic materials available at the present time, alumina base and zirconia base powder. Information concerning these materials is given in Table V. Zirconia base coatings have the highest heat insulating value, while alumina base coatings, though somewhat less effective as heat barriers, are harder and possess greater strength. Both of these materials, however, have very high thermal barrier properties as compared with other materials such as cermets and metals.

These coatings are usually applied in thicknesses from 0.005 in. to 0.025 in. depending on their intended use. They have good resistance to thermal shock and are resistant to many types of abrasion at temperatures up to 3,500 F. Several cermets have been developed in an attempt to raise the expansion coefficient of heat-resistant coatings. Extensive work in this field will no doubt result in the development of new and useful coating materials.

Table V—Properties of Ceramic Sprays

	Alumina	Zirconia
Melting Point	3700 F	4600 F
Bulk Density (g/cc)	3.2 to 3.4	5.2 to 5.3
Porosity (per cent)	6 to 10	6 to 10
Thermal Expansion (per F, x 10–6)	4.3	6.4
Thermal Conductivity* (BTU/hr/ft²/in./F)	19	8
Deposition	15 sq. ft. per hr. .010 in. thick	10 sq. ft. per hr. .010 thick
Color	Grey	Tan-Brown

* On this same scale Stainless Steel (18–8) would read 185 and Carbon Steel 320.

Alumina type has excellent hardness and resistance to many types of abrasion. Particle Hardness is 9.0 on the Moh scale. Zirconia type is softer than alumina but has superior heat insulating properties. Particle hardness is 8.0 on the Moh scale.

FUSING

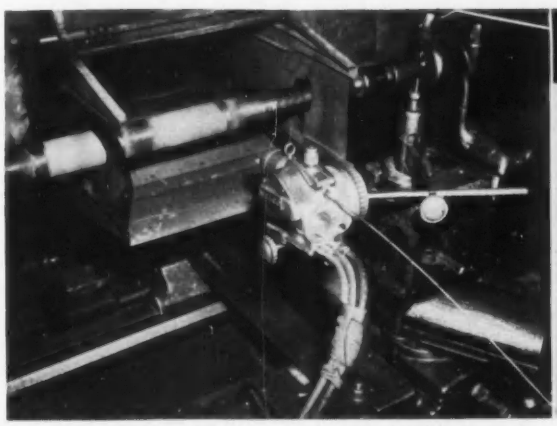
The self-fluxing alloys listed in Group 1 above are usually fused in place after spraying, although for many uses fusing is not necessary. The process is carried out by first cleaning and roughening the surface to be coated, such as by grit blasting. The base is then pre-heated to 200-300 F. with a torch or the spray gun. Spray metal is applied and built up to the desired thickness. The coating is then heated to between 1850 and 2050 deg F. to fuse the coating in place. The fusing increases the strength of the bond to the base and eliminates the porosity. In many corrosion resistant applications lack of porosity may be an important requirement.

Where maximum density is not essential a simplified technique called "semi-fusing" may be used. In this process the part is pre-heated to 350 to 450 deg F, a thin bonding coat (0.002 in. to 0.004 in.) applied, the part heated to 1300 to 1400 deg F, and the coating built up to the required dimensions.

Semi-fused coatings are nearly as impermeable as fused coatings and they take an excellent finish. Semi-fusing has an advantage over full fusing in that it reduces the danger of distortion of the part and the problem of running or pulling away of the coating at the edges. Semi-fused coatings may be built up to any desired thickness since the coating is never brought to a liquid condition and will not run. This technique is applicable to any base material which can be safely heated to 1400 F.

EDITOR'S NOTE: Spray metallizing is only one of several methods of applying protective metal coatings on base materials. "Zinc Coatings for Protecting Steel," by Ernest W. Horvick, in *Product Engineering*, December 1955 page 158 covered hot-dip and continuous galvanizing, electroplating and sherardizing as well as metallizing and discussed the electrochemical advantages of zinc as a coating material.

Vacuum metallizing received further coverage in "The Future of Vacuum Coatings," by J. G. Seiter, p C12 of the Product Design Handbook Issue for 1956. The basic process is described and examples given of different coatings in varied applications.



Left—Steam turbine shaft is sprayed with Monel from a wire gun to resist corrosion. Right—Sprayed aluminum on head of automotive valve doubles its life. Previously dipped, sprayed coating lowers costs and has more uniform coating. Valves are preheated in gas flame and automatically conveyed while rotating past spray from a wire gun.

Fan Cooling —Influence of Altitude

How variations in air density and temperature affect heat transfer in cooling systems at altitudes from sea level to 15,000 ft; increasing air volume flow by higher shaft speed or larger fan; effect of power-line frequency variation on cooling-fan operation; summary of factors influencing motor hp and fan performance.

J. CONSTANT van RIJN Chief Engineer, Rotron Mfg. Co.

FLUSHING AMBIENT AIR through equipment enclosures is the simplest and most commonly used method of cooling. If the required amount of cooling air is determined for sea-level operation, fan or blower performance normally must be increased for operation at lower barometric pressures of higher altitudes. When equipment is to be used at varying altitudes, cooling requirements must be carefully evaluated, since for altitudes of 10,000 to 15,000 ft required fan-motor hp may be as high as 50 times that at sea level when all factors are considered.

Cooling efficiency is primarily dependent on air density and air temperature which are related by the following basic thermodynamic equation:

$$Q = W \Delta T C_p \qquad (1)$$

where Q is the amount of heat transferred, W is the mass (weight) of air flow, ΔT is the temperature difference between the surface being cooled and the cooling air, and C_p is specific heat of the cooling air. A change in altitude affects efficiency of the cooling process because of variations in air density and air temperature. One change may compensate for the other, or they may be additive in their effects.

The cooling process may be analyzed by considering the equipment enclosure to be a heat exchanger. Heat is passed from components in the enclosure to cooling air flushed through. The driving force in the heat exchange process is the temperature difference between cooling air and component surfaces; this is called the "available temperature difference."

In a box filled with components like vacuum tubes, transformers, or resistors, conditions of heat transfer are more complex than in a geometrically simple heat exchanger. A mathematical evaluation based on a simple heat exchanger provides valuable preliminary fan performance and data. But calculations provide approximations only, and should preferably be complemented by prototype performance measurements.

Effect of Density Change

If temperature of cooling air entering an enclosure is constant with increasing altitude, such as encountered in a heated room at a high-altitude location, heat-exchange efficiency remains constant for a constant mass flow of air. To maintain same degree of cooling from low to high altitudes a constant weight of air must be moved through

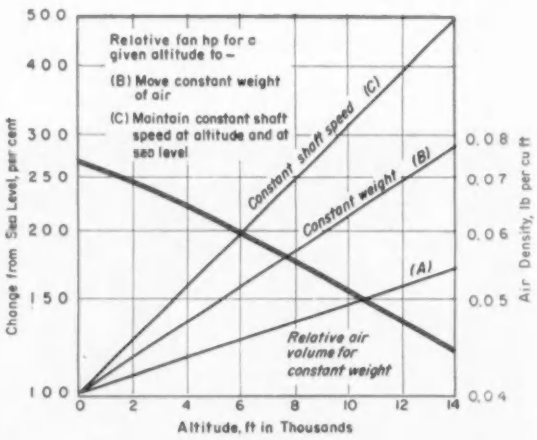


Fig. 1—Variation in air density, in volume per unit weight of air, and in required fan hp, for air at 20 C from sea level to 14,000 ft altitude. Lettered curves show how (A) volume of a constant weight of air increases with altitude; (B) fan-hp required to move a constant weight of air increases with a given altitude; and (C) required fan-hp further increases if fan is operated both at a given altitude and at sea level and fan shaft speed remains constant.

the enclosure. For a constant temperature (20 C), air density decreases with altitude as shown in Fig. 1. Therefore, to maintain constant mass flow as altitude increases, volume of air flow must be increased as shown in curve (A).

Effect of Combined Temperature-Density Change

When both temperature and density change, efficiency calculations for the enclosure as a heat exchanger are more involved and now also depend on whether the air-flow pattern is laminar or turbulent. Laminar or turbulent flow conditions are normally present when air is forced through pipes or ducts as shown in Fig. 2. Laminar flow usually occurs in a finely-divided duct with a low air-flow rate, such as encountered in heat exchangers; relationship between duct diameter and air velocity for laminar flow is shown at left in Fig. 2. An enclosure filled with components is not a duct or pipe, but when air is flushed through, flow is usually laminar. When a blower is located inside the box and has a duct connected to the blower outlet which leads air over fined anodes or through narrow cavities, turbulent flow is produced.

For laminar flow in a geometrically simple heat exchanger, required mass flow is closely proportional to the third power of the difference between cooling-air and hot-surface temperatures. For turbulent flow conditions, required air-mass flow is approximately proportional to the first power of the available temperature difference. In an enclosure filled with heat-emitting components this available temperature difference may be difficult to pinpoint. However, useful preliminary calculations can be made for selected critical surfaces like electron tube seals.

Use of Outside Cooling Air

If cooling-air temperature drops with increasing altitude, such as when using outside air, the more favorable temperature difference may compensate for lower weight of air moved with reduced air density. From Eq (1), the point of compensation occurs when the increase in temperature difference ΔT between heat-exchanger surface and cooling air is equal to reduction in weight of air W moved with a constant volume at reduced density.

The series of curves shown in Fig. 3 have been derived for both turbulent and laminar flow to illustrate the required change in heat-exchanger surface temperature, with altitude, for constant cooling efficiency at a constant air-volume flow. Curves for turbulent flow are shown in color and are based on the following equation.

$$\frac{W_A}{W_S} = \frac{T_{BS} - T_{CS}}{T_{BA} - T_{CA}} \qquad (2)$$

where W_A is weight of air flow at an altitude, W_S is weight of air flow at sea level, T_{BS} is surface temperature of heat exchanger at sea level, T_{BA} is surface temperature of heat exchanger at an altitude, T_{CS} is temperature of cooling air at sea level, and T_{CA} is temperature of cooling air at an altitude.

Curves for laminar flow are shown in solid lines and are derived from the following equation:

$$\frac{W_A}{W_S} = \left(\frac{T_{BS} - T_{CS}}{T_{BA} - T_{CA}} \right)^3 \qquad (3)$$

Use of these equations allows designer to determine maximum heat-exchange surface temperature for best choice of compactness and economy in fan system design. For example, if an equipment designed for outdoor sea-level operation at a max ambient temperature of 47.5 C is installed at an altitude and outdoors, cooling-air temperature can be assumed to decrease with altitude as defined in NACA Report TN-1200 and shown in the bottom curve in Fig. 3. Under these conditions there

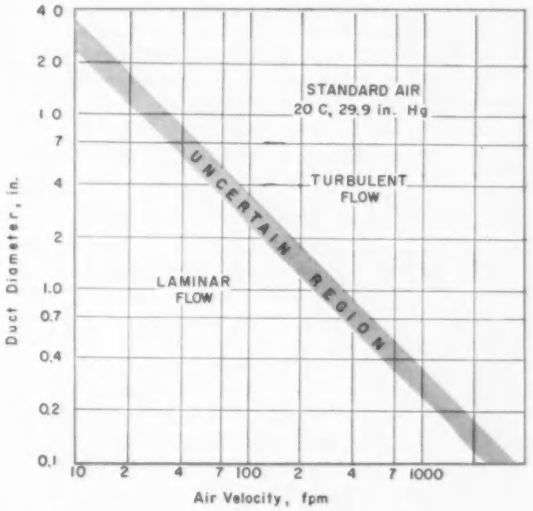


Fig. 2—Relation between duct diameter and air velocity for laminar and turbulent flow. Laminar flow usually occurs in a finely divided duct with relatively low rate of air flow. Turbulent flow usually is found in open ducts at higher air velocities.

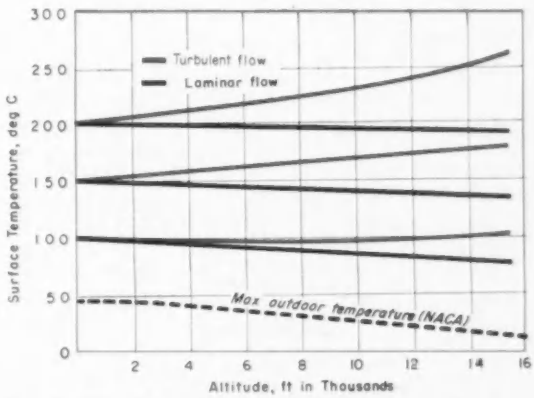


Fig. 3—Required change in heat-exchanger surface temperature T_S with altitude for constant cooling efficiency at a constant volume of outside cooling-air flow. Bottom dashed curve indicates maximum outdoor temperature according to NACA Report No. TN-1200. Black curves indicate laminar flow conditions while red curves indicate turbulent flow. Curves are derived from equations described in text. Most efficient cooling-system design is obtained only if surface temperature remains constant over altitude range; for turbulent flow a surface temperature of 100 C is efficient, while for laminar flow temperature of 200 C is best. When surface temperature increases with altitude, cooling efficiency decreases; when surface temperature decreases, over-cooling occurs and fan is over-powered.

will be a critical heat-exchanger surface temperature, independent of size of heat exchanger or amount of heat moved, at which compensation will occur. The heat exchanger in this case may be the envelope of a vacuum tube or a critical component.

This critical temperature occurs at that hot-surface temperature which remains constant throughout variations in altitude and temperature. In this case it is about 100 C for turbulent flow conditions and 200 C for laminar flow, as shown in Fig. 3. Increasing initial sea-level surface temperature T_{ss} will, in either case, cause temperature to increase with altitude. Decreasing sea-level temperature reduces surface temperature with altitude; however, overcooling then occurs and the fan or motor is oversized for the application.

Increasing Volume Flow

When ambient cooling-air temperature at altitudes is too high to offset effect of decreased air density, the volume of cooling air flushed through the "piping system" of the equipment enclosure must be increased. This volume can be increased in two ways.

First, for a given piping system, increasing fan shaft speed increases air volume in direct proportion. For large blowers or fans, such increase in speed can be obtained using a belt drive. For smaller, direct-driven fans using induction motors, speed variations are limited to decreasing the number of poles, thereby increasing speed in fixed increments. For example, at 60 cycles 6-pole motor speed is 1140 rpm, 4-pole speed is 1725 rpm, and 2-pole speed is maximum obtainable, 3450 rpm.

The second method of increasing fan flow is to increase fan size. For a fixed piping system, delivered air volume increases in proportion to the cube of fan dimensions. For example, at 10,000 ft air volume must be increased 1.47 times to maintain constant cooling temperature, which calls for a 13.5 per cent increase in fan size.

Increase in volume flow also affects hp requirements. The load on the fan shaft is proportional to the product of volume and pressure. For a fixed piping system pressure increases as the square of flow. Assuming the air is of constant sea-level density, required hp increases as the cube of volume flow. For the 1.47 increase in volume flow in the previous example, shaft hp must therefore be increased 3.1 times. However, when density decreases with altitude increase, both air pressure and hp change in direct proportion. Therefore, for a 10,000 ft altitude, required hp increase would only be 2.12 times instead of 3.1 times required at sea level. This is shown in curve (B) of Fig. 1.

If this same higher-delivery fan is to be used at both altitude and sea level at the same shaft speed, which is the usual case, then the fan will also have to move the air at the higher sea level density, and again a 3.1 increase in shaft hp is required as shown in curve (C), Fig. 1. That is, for constant fan speed and constant weight of air flow, fan shaft hp increases with altitude and again if brought back down to sea level. However, weight of air displaced at sea level is now greater, and overcooling will exist.

When departing from sea-level air temperature and pressure conditions, required increase in fan performance is only one of the factors to be evaluated when complete specifications of fan performance are obtained by testing the operating model under laboratory conditions. Also to be considered are: (1) maximum and minimum ambient temperatures under which the equipment will be operated and (2) variations in power-line frequency.

Variation in power-line frequency affects required fan performance. Assuming the fan is driven by an induction motor, which is the most desirable type, motor shaft speed will vary in direct proportion to line frequency; hence the output of the fan will vary in proportion to the third power of shaft speed. Domestic or export equipment may have to be designed for operation at both 50 and 60 cycles; the fan must then be dimensioned to give required performance at the lower 50-cycle shaft speed. However, when this fan is operated from 60-cycle lines motor speed increases in direct proportion and fan load on the motor increases by $(60/50)^3$ or 1.73 times that at 50 cycles. Military equipment is often specified to operate over a wider power-frequency range, for example 48 to 63 or 45 to 67 cycles; fan hp load increase is then 2.23 and 3.3 times that at the lower speeds.

Finally, equipment is often required to operate satisfactorily in cold unheated locations or outdoors, and under higher than standard barometric pressures. In these cases air density increases and fan load increases in direct proportion. However, because of the available temperature difference previously indicated for outdoor operations, cooling of the enclosure will not require the full volume of air available. But the fan motor must have sufficient hp to operate safely under the increased load due to increased air density.

For example, a decrease from room temperature (+20 C to −20 C) increases air density and fan shaft load 1.12 times. Military equipment operating down to −55 C requires a motor hp increase of 1.36 times.

A summary of the various factors which influence required motor hp and fan performance are listed in Table I. They are established on the basis that air requirements are established at room temperature or 20 C ambient, that flow is turbulent, and that critical surface temperature is 150 C. The assumption of 150 C corresponds to a typical vacuum-tube seal, often the most temperature-sensitive item in an electronic cooling application. For higher hot-surface temperatures the various multipliers in Table I become smaller, for lower temperatures, larger.

Sample Calculation

As a design example, assume that an enclosure is found to be adequately cooled at 24 C and 29.92 in. Hg barometric pressure by an airstream of 100 cfm delivered at a static head of 1.4 in. water column (W.C.). The specification calls for operation up to 10,000 ft in an ambient of −55 to +72 C and a power-line frequency range of 50-60 cps for the fan motor. The most critical element is a vacuum-tube seal with a maximum operating surface temperature of 140 C.

The air volume of 100 cfm at 1.4 in. W.C. represents 100x1.4x0.0001573 or 0.022 air hp, neglecting air-velocity head as small in comparison to static head of 1.4 in. W.C. The factor 0.0001573 is a constant used in fan design and applies to standard air at 20 C and 29.9 in. Hg. If the

Table I—Summary of Factors Influencing Required Fan Motor Hp

Data is for turbulent air flow and critical surface temperature of 150 C. If fan is to also be operated at −55 C all relative-hp factors should be multiplied by 1.36.

Altitude	Sea Level, 29.92 in. Hg				8,000 ft, 22.22 in. Hg		14,000 ft, 17.57 in. Hg	
Ambient temperature	20 C	45 C	55 C	72 C	45 C	72 C	45 C	72 C
Available temperature difference for 150 C surface	130 C	105 C	95 C	78 C	105 C	78 C	105 C	78 C
Air density, lb cu ft	0.075	0.069	0.067	0.064	0.0513	0.0472	0.0408	0.0377
Relative Air Flow By weight	1	1.24	1.37	1.67	1.24	1.67	1.24	1.67
By volume	1	1.35	1.54	1.96	1.814	2.652	2.28	3.322
Relative back pressure	1	1.82	2.37	3.84	3.29	7.04	5.2	11.03
Relative Shaft Hp 60 cps	1	2.46	3.65	7.54	5.97	18.7	11.85	36.6
50 to 60 cps	1.73	4.26	6.3	13	10.3	32.6	20.5	63.2
45 to 67 cps	3.3	8.18	12.05	24.9	19.7	61.8	39.1	121

static blower efficiency is 35 per cent, blower motor power needed is 0.022/0.35 or 0.063 shaft hp. Air density at 24 C and 29.92 in. Hg is 0.0741 lb/cu ft. The volume delivery of 100 cfm is therefore equal to 100x0.0741 or 7.41 lb/min.

Under laboratory test conditions the available temperature difference is 140−24 or 116 C, and under the most adverse temperature conditions is 140−72 or 68 C. With turbulent air flow, weight of air flow must be adjusted in inverse proportion to the change in available temperature difference, hence 116/68x7.41 is equal to 12.64 lb/min of air which must be delivered. At 10,000 ft, NACA barometric pressure is 20.58 in. Hg. These pressure and temperature conditions give a density of 0.044 lb/cu ft. Therefore, the required 12.64 lb/min corresponds to 12.64/0.044 or 287 cfm. When using an induction motor, its speed should be constant regardless of load, and the blower will therefore have to move 287 cfm at all altitudes and temperatures.

Since pressure over a fixed piping system varies as the square of the volume, 287 cfm will have to be delivered against $(287/100)^2$x1.4 or 11.5 in. W.C.; the blower must therefore be capable of delivering 287 cfm at 11.5 in. W.C. corresponding to 0.52 air hp. Again, at 35 per cent static efficiency, required shaft power is 1.46 as against the original figure of 0.063, an increase of 24 times.

The requirement for operation over a power-line frequency range of 50 to 60 cps corresponds to a shaft speed change of 50:60. The blower must therefore move 287 cfm at 11.5 in. W.C. at 50 cps shaft speed. At 60 cps, required shaft power will therefore increase to $(60/50)^3$x1.46 or 2.56 hp.

Finally, the blower motor should not be overloaded when ambient temperature is reduced to −55 C, under which condition density is increased (for 29.92 in. barometric pressure) to 0.102 lb/cu ft. Motor hp must therefore be further increased to (0.102/0.0741) 2.56 or 3.58 hp, an increase of about 57 times the original 0.063 hp.

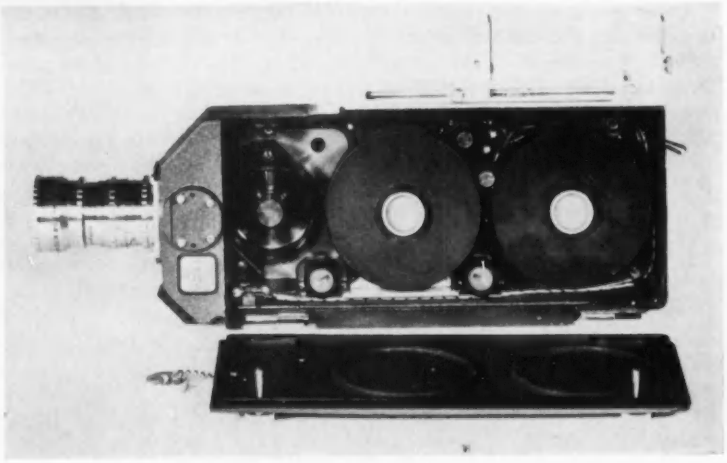
Under normal circumstances equivalent heat of the aerodynamic output of a cooling fan is transferred to a relatively large volume flow and hence causes a small rise in air temperature. When fan performance is greatly increased but piping system remains the same, most of the output is transferred to heat inside the enclosure. Most of the heat dissipated by the motor is generally added to this. For this reason it is possible for the fan to heat the enclosure rather than cool it, and fan motor input watts should always be added to the heat load. In the previous example the 2.56 hp is equivalent to about 1900 watts.

When faced with the situation in the design example, fan requirements can be reduced by improving heat-exchanging efficiency of the cooling process and by reducing back pressure of the piping system. The feasibility of using different fan shaft speeds for different altitudes should also be considered. For example, adjustments may be made when shifting from 50 cps to 60 cps operation, by changing pulleys on a belt drive or using a different diameter or different width of blower wheel in the same blower housing, or a different pitch propeller on an axial fan.

If these possibilities have been exhausted and the required shaft hp still appears too high, the only recourse is to use a fan drive motor in which shaft speed varies with load. An example is a series-type commutator motor or a special variable-speed induction motor designed for high-altitude cooling applications. Such motors have an rmp and hp design rating corresponding to requirements of the lowest density air; no provision is required for added power at the higher sea level densities because motor rpm and motor load automatically decrease. Variable-speed fan operation is, however, primarily suitable for high altitude aircraft applications. From Fig. 1, the fan hp increase due to altitude alone is only 3.1 at 10,000 ft and 4.9 at 14,000 ft; use of special drive motors which vary shaft speed automatically with altitude are only effective within this range.

See also "Selecting Motors for Fans and Centrifugal Pumps," page 215, a nomogram relating motor torque, power and speed for applications where torque varies with the square of speed and power increases with the cube of speed.

LIGHT ENOUGH (9 LB) TO HOLD BY HAND, the industrial version of Fairchild's new high speed camera can take pictures at from 32 to 5000 pictures per sec, black and white, or in full color without correction filters. The wide speed range is possible with a series of motors which are quickly interchangeable. In the picture, left, the motor is directly above the operator's right hand. The pictures-per-second range for the four battery powered, 28 v d-c motors are: 32-200; 100-1000; 300-3000; and 500-5000.



THE AIRBORNE VERSION OF THE CAMERA has a 100 ft film capacity, but Fairchild announces that a new thin base film which will be announced this fall will give it a 150 ft capacity. All standard 16 mm film can be used and no special processing is necessary. Not shown in this view is the right angle drive unit which gives the camera a range of from 32 to 2000 frames per sec, also with the aid of interchangeable motors.

High Speed Cameras Have Interchangeable Motors

High speed, high quality pictures within a range of 5000 frames per sec are possible with the new Motion Analysis Camera made by the Fairchild Camera & Instrument Corp., Syosset, N. Y. This 16 mm camera, using rotating prisms, has been designed for industrial use (held by operator, above) and for airborne use (with side cover removed, below). Both models have film capacities of 100 and 150 ft, using daylight loading spools, and a 400 ft film capacity camera is now being considered.

The industrial model will operate at from 32 to 5000 frames per sec, according to the motor used. Four motor setups are available, and can be interchanged within a minute by a twist–lock and unlock. The speeds for the different motors are 32 to 200 pictures per sec; 100 to 1000 pps; 300-3000 pps; and 500-5000 pps. By switch control on the small battery power unit carried, it is possible to get 4 different speeds within each motor range. A 28 v, d-c portable, battery power supply unit is used. The camera weighs 9 lb. The lens provided is 75 mm, f/1.9, but other lens from 13 to 152 mm are available. Camera cost: $1190.

The airborne model operates on the

same power supply, and has a right angle drive unit to keep the camera thin. Its maximum speed is 2000 frames per sec. Dimensions are 11 x 4½ x 4 in., and weight is 11 lb. Cost: $1325.

The motors can furnish maximum acceleration in a minimum time, and the camera has sufficient power to start at high speed. The camera will operate at 55 g's constant acceleration, 10 g vibration at or through a range of 10-500 cycles in one sec, at temperatures from −65 to 200 F, 100 g's shock without causing optical distortion.

A special glass was used for the 4 sided prism to make it as nearly "water-white" as possible and still have a high index of refraction and low dispersion. The image produced is free from color fringing, and high speed color photography is possible without the use of color correction filters.

Fairchild stresses simplicity of operation with its new cameras. There is only one switch (on-off) and two sockets on the camera: one for motor power and one for the timing light.

At rates up to 1000 frames per sec, an adjustable brake prevents overrun of the feed spool when the camera is stopped and started for several runs on a single roll of film. Also, the speed can be varied while the film is passing through the camera.

The camera has been used to photograph the ejection of a pilot's seat from a rocket propelled test sled travelling 600 mph with deceleration forces in excess of 60 g's. Camera speed was 800 frames per second.

In another test a camera with color film was mounted on a sled travelling at supersonic speeds. Initial acceleration was 200 g's. No special brackets were needed for any of the tests. Fairchild claims that its motion analysis camera is 60 lb lighter than comparable systems.

In medical photographic work, 2000 frames per sec are used for heart studies, while human muscular action such as ballet, typewriting, boxing, etc. can be slowed down sufficiently at 1000 frames per sec. Studies of human vocal chords and eardrums need speeds of 4000 frames per second.

Other applications are in the packaging or automation fields, machine tool work analysis, liquid flow analysis, and missile or ballistic tests.

Pint-Sized Gas Turbine for Light Plane Use—

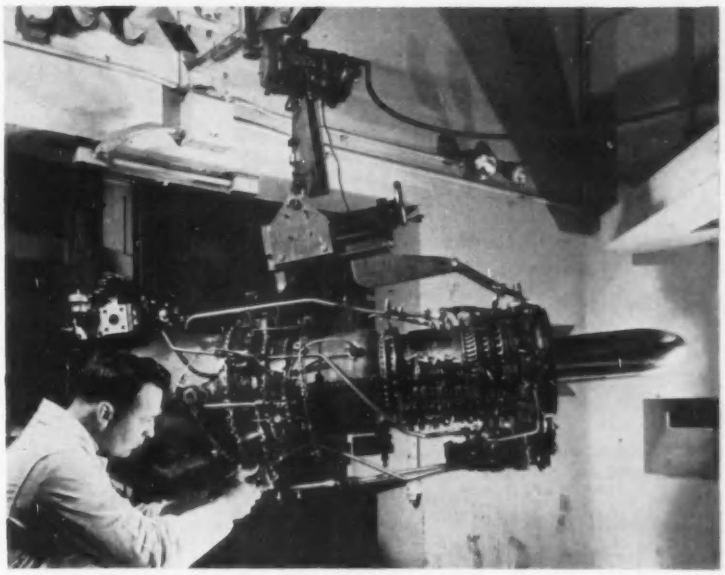
Actually a midget, as gas turbine engines go, General Electric's new T58 engine manages to pack a little more than 1000 hp into a package 59 in. long, 16 in. in dia. Total weight, not counting the special gearing on the rear end (directly above engineer's head in photo) the engine weighs 250 lb. With the gearing, the weight is boosted to 325 lb. Specific fuel consumption is 0.69 lb/hp-hr. The engine was developed by GE for the Navy, and its initial application is to power helicopters, specifically the Sikorsky S-58, which will have two of the new engines for its power plant. Besides helicopter use, GE foresees the application of the T58 engine to fixed-wing aircraft either as a turboprop or a turbojet.

After the air is compressed, passed through the combustion chamber, and through a two-stage turbine which drives the compressor rotor, the hot gas flow continues through a one-stage power turbine before being exhausted. This last turbine GE calls a "free turbine," and carries its own power output shaft, which, through reduction gears, drives the helicopter's rotors.

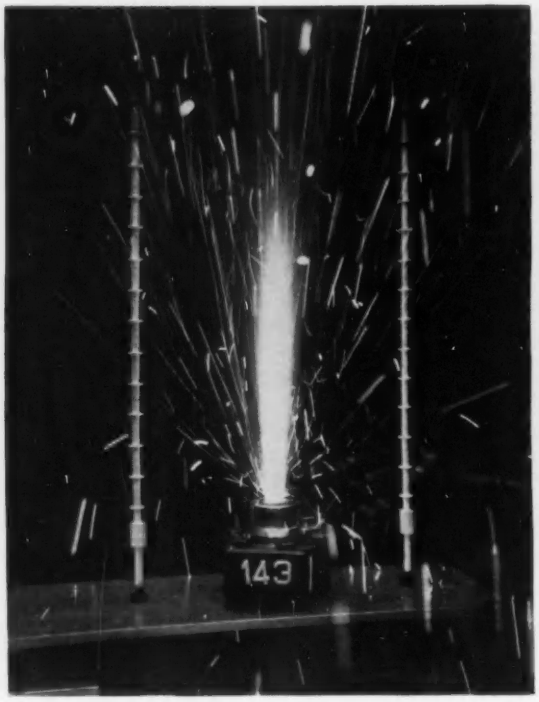
Turbine inlet temperatures were purposely kept at a moderate level to get longer life, and to minimize the need for strategic materials. The compressor blades weigh ¼ oz each and are not much larger than a man's fingernail. The T58 is designed to operate over a wide range of output power at a constant output shaft rpm. On performance, GE claims that the T58 will do better than reciprocating engines because of its greater hp-to-weight ratio. For example: powering a utility helicopter, it will carry 100 per cent more payload; increased economy; and higher flight speeds.

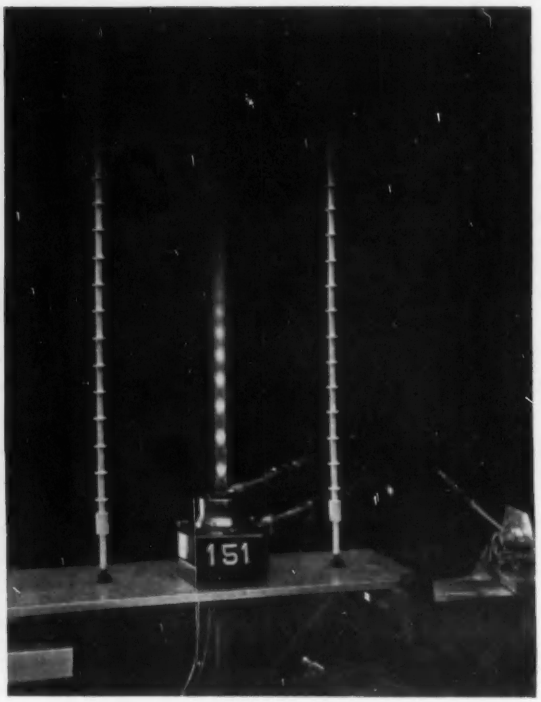
On the control side, the manual rotor speed control has been replaced with an automatic control which operates from the engine control lever position.

GE feels that there will be at least 600 commercial passenger carrying helicopters in operation by 1966, and would like to get a piece of that business. To do this, GE announced that its Small Aircraft Engine Dept. now has more than one-million sq ft of plant, lab, and test facilities spread out through New England, and expects to invest $20-million into this department within the next five years.



GENERAL ELECTRIC'S NEW small, lightweight, better than 1000 hp gas turbine engine, soon to be installed in Sikorsky's S-58 helicopter. Not counting the special reduction gearing at far left, the total weight of the engine is 250 lb. Dimensions are 16 in. dia; and 59 in. long. Not limited to helicopters, the engine can easily be modified to a power plant for fixed wing aircraft.





STAINLESS STEEL ROCKET NOZZLE, left, melts under high temperatures in combustion chamber, while the copper nozzle, right, is unaffected. In the present series of tests, a premixed propellent of gaseous hydrogen and oxygen is used, and the length of the combustion chamber is reduced to the point at which performance begins to fall off.

The Search for Rocket Engines

Future rocket engines being tested in the Aerodynamic Lab., of the Ohio State University, show what happens when 304 stainless steel was used in the combustion chamber (left) and when copper was used (right).

The point of failure of the stainless steel unit was at the exhaust nozzle inlet, the point of maximum heat transfer. The heat transferred from the hot gas to the wall could not be transmitted by the stainless steel to the coolant at a sufficient rate to maintain the surface temperature of the stainless below its melting point. This shows its poor thermal conductivity, while copper, which can transfer heat rapidly, prevented its surface temperature from reaching the melting point.

The Rocket Research Lab. is the only one in this country where research on steady-state high pressure flames is in progress. Objectives of the studies which are sponsored by the Aeronautical Research Lab. of Wright Air Development Center are to learn more about the combustion processes, and their application to aircraft. Also, under study are the conditions under which different combination of premixed propellants will produce stable flames. The models shown here are just two of the burner and rocket engine designs which have been constructed and tested. Many materials were tested, with copper giving the best results.

The fuel and the oxidizer are fed into the combustion chamber and burned at a constant pressure which may run from 200 to 1500 psi. The propellant, liquid or gas, is usually fed into the combustion chamber in a number of individual streams that impinge upon each other, to assure good mixing. No material will stand up directly to the full flame temperature, which may run as high as 5500 F. The wall must be cooled by some type of coolant such as water, either the fuel or oxidizer before being burned, or by forcing some of the fuel through a porous or laminated wall (sweat cooling).

The fuel and oxidizer are mixed together before being fed to the combustion chamber. Therefore, the chamber size can be held to a minimum. This method is somewhat dangerous because an explosive gas mixture exists between the mixing chamber and the combustion chamber. Under certain flow conditions the flame will flash back and detonate to the mixing chamber. To prevent this flashback, best results have been obtained at 200 and 300 psi chamber pressure.

In one of the test rocket engines at Ohio State, the combustion chamber is 1 in. long x 1 in. in dia; the nozzle is 1⅛ in. long; thrust is 25 lb; gas temp inside combustion chamber is 5490 F; chamber pressure is 300 psi; propellant flow rate 5 lb/min; propellant is premixed hydrogen and oxygen; exhaust gas temp is 3140 F; and exhaust gas velocity is 7000 mph.

Automation for Short Run Production

Where the quantities involved are tens or hundreds instead of thousands, General Mills' Autofab offers a short run assembly machine with some degree of automation. The short run Autofab, a companion to the multiple-head automatic assembly machine of the same name, was designed specifically to give a flexible machine for attaching electronic components to printed circuit boards for small production runs and experimental work and operate at a savings over a large programmed system.

This single head machine can be changed over from one component to a different one in less than a minute. The complete inserting tool can be removed as a unit after one locking lever is turned, and adjustment of the tool is not disturbed. The lead crimping mechanism can be locked or unlocked as a unit with one motion. The component feeding magazine (not shown in the illustration) is about 2 ft long, and clips in place.

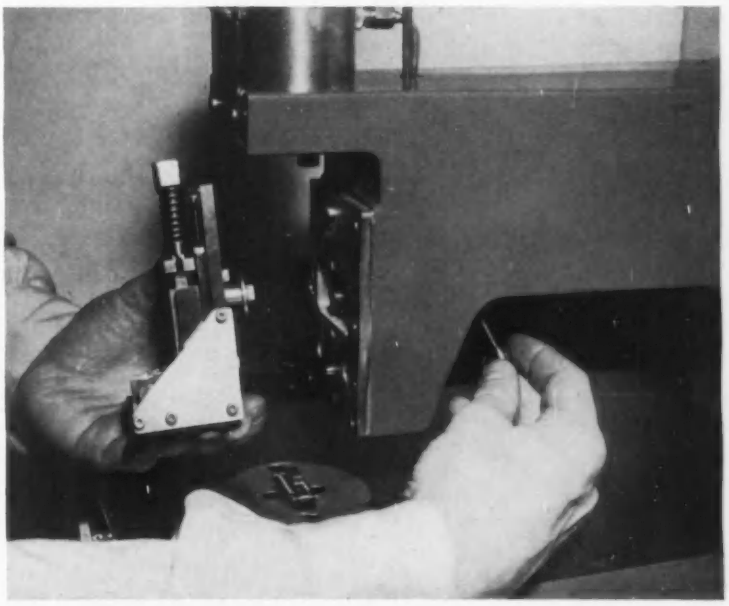
An alternative attachment permits tape feed. No component preparation is necessary. The leads are trimmed in the machine just before insertion. If necessary, the machine can use pre-trimmed leads.

The operator hand feeds the circuit boards into the holding fixture but this is the only motion required. The insertion cycle is automatically actuated when the board hits the proper position in the fixture. The machine is designed for standard $\frac{1}{16}$ in. circuit boards, but will handle boards from $\frac{1}{32}$ to $\frac{1}{8}$ in. thick.

This single head Autofab is designed for cylindrical components, and will not mount on center distances from 0.562 to 2.00 in. tight to the board. Components from $\frac{3}{8}$ to $1\frac{1}{16}$ in. long and $\frac{1}{8}$ to $\frac{1}{16}$ in. in dia can be used.

Component tolerances ± 0.031 in. on length and dia, wire dia from 0.028 to 0.045 in. ± 0.003, and ± 0.031 on eccentricity of lead attachment to the body of axial leaded components. The single head Autofab is a bench mounted unit 10 in. wide, 22 in. deep, 17 in. high, and weighs 60 pounds. Power requirements are 110 v, 60 cycle single phase a-c, and compressed air at 60 psi.

OPERATOR INSERTS printed circuit board into holding fixture. The insertion cycle takes less than $\frac{1}{2}$ sec, and is actuated automatically when the board is pushed all the way into the holder. The card holder is the unit under operator's left hand, and is adjusted for card size by unlocking the thumb screw at operator's right hand. The card holder is locked in position by an electromagnetic device.



THE COMPLETE INSERTION tool assembly is removed by releasing the locking lever. Another assembly is easily installed. The component magazine, not shown, is put in place by hooking it onto a clip at the bottom of the tool assembly. The crimper device is shown below the tool assembly and can be removed by turning the knurled knob at far left. Leads are trimmed to length in the machine.

BY GOING TO AN EPOXY RESIN MOLDING instead of hand assembled individual parts, estimated cost savings were 80 per cent. An essential part of the process was the use of glass marbles, which strengthen the part while preventing shrinkage. Screws shown extruding into the mold are backed out when the resin has hardened, leaving cast threads.

THE BOTTOM OF THE DEVICE shows the sharp edges which were obtained with the epoxy resin. The finished part was vapor coated with aluminum to give all the orifices a reflective finish. The work was done on a Navy contract.

Precision Molding Technique With Epoxy Resins

Using a new technique in molding epoxy resins, Northrop Aircraft, Inc., Hawthorne, Calif., is getting an optical finish in addition to precision in complex finished products. In a contract for optical testing devices, the concept of electroforming each segment of the device for assembly was reversed, and a segmented mold was made and assembled to the required precision.

The process consists of slush molding all surfaces of the master mold, which is then placed in a vacuum chamber to expand the resin and remove all of the air bubbles. The mold is then filled with resin and inexpensive glass marbles which reduce the chemical heat caused by the catalyst in the resin, and prevent shrinkage of the part itself during the curing period. The mold itself cost approximately as much as one part would have cost under the original concept.

The elimination of shrinkage caused by the insertion of the marbles and other additives results in a dimensional accuracy with a tolerance of 0.0015 in. All surfaces are optically flat, and either radii or knife-edge corners are accurately reproduced.

One Microsecond Parallel Adder

Adding two 53 binary-digit numbers in one microsecond is possible with a new parallel adder using one-megacycle circuitry just developed at the National Bureau of Standards, Washington 25, D. C. The high speed is obtained with a unique arrangement which permits the formation of large groups of carries.

Previously, parallel adders had the problem of carry propagation. If no carries were present, all the sum digits could be formed simultaneuosly, in parallel. However, there is always the chance where a carry produced in the last significant digit position causes another carry to be produced in the next digit position, which in turn produces a carry in the third position, etc. The time required for a carry to propagate from the least to the most significant digit position in this way is called the maximum carry propagation time, which has generally limited the speed of parallel adders.

Previously, attempts to reduce this time have been directed towards speeding up the carry from one digit position to the next. With NBS' method, whole groups of adjacent carries are formed simultaneously and independently of each other. It was found possible to generate all carries in a limited number of time periods or phases; and for the 53-binary-digit adder, all 52 carries are formed in three phases.

The complete addition operation is performed altogether in five phases:

1. Each of the two operands to be added is made available in parallel.
2. The four least significant carries, C_1 through C_4, are generated in parallel from the four least significant digits of each operand. At the same time other digits of the operands generate auxiliary carries which are formed at certain digit positions.
3. The second group of carries, C_5 through C_{20}, is generated in parallel.
4. The last and largest group of carries, C_{21} through C_{52}, is generated.
5. Finally, all sum digits are formed in parallel in a conventional manner.

Subscribe to Index of Electronic Patents

Information For Industry, Inc., a company that lives up to its descriptive title by making available to industry and business an index of chemical patents (*Product Engineering*, May 1955, p 193), has just announced that the process will be duplicated for electronics patents. Using an indexing system called Uniterm, the electronics subjects are reduced to basic words to simplify the search for a patent relating to any particular subject.

The user can make a broad or specific search of electronics patent information on: telephony, telegraphy, radar, television, radio, components, instrumentation, nuclear energy, magnetics, vacuum tubes, solid state devices, propagation, arionics, circuitry, miniaturization, automation, printed circuits, facsimile, industrial control and other subjects.

A company subscribes to the Uniterm index of electronic patents, and each month a new issue, including the new patents just listed and the ones listed in the previous issue, is mailed to the subscriber. The subscriber then returns the previous issue to Information For Industry, Inc., 1108 16th St., N.W., Washington 6, D. C.

The subscription consists of two volumes, each about one inch thick. One volume contains the indexing system in which basic titles of different subjects in the electronics field are reduced to numbers. The second volume contains abstracts of the patents, and the patent number. If the subscriber wants a complete patent, he can write to the U. S. Patent Office.

New Headlight Dimmer Gets Selective

A different type of headlight dimmer looks only for the bright spots (headlight) and does not see the general illumination. Oncoming headlights are spotted 1500 ft away, and taillights at 300 ft. Key to the dimmer, which was designed at the Rabinow Engineering Co., 7212 New Hampshire Ave. N.W., Washington, D. C., is a scanning system consisting of a small disk driven by a small permanent magnet d-c motor (an air motor can be used) mounted just before the phototube opening. In the disk are holes 0.015 in. in dia, which are arranged in a spiral so that a complete field is viewed in one revolution. The dimmer reads the difference between the background and the light, and the darker the night, the more sensitive the unit becomes. It does not dim on the reflection of its own light, and can be mounted inside the headlight assembly if desired. The circuit is so arranged that when there are no bright spots in field of view, the relay controlling the headlights directly, remains energized until a peak detector produces a negative voltage in response to light signals.

To eliminate any oscillation if the oncoming vehicle dimmed his lights, a holding circuit is provided that raises the sensitivity of the device by a factor of 10 when the lights are down.

A Ductile, Direct Plated Chromium

To prove the quality of a new chrome plate on the 61S aluminum tube shown here, Tiarco Corp., Clark, N. J. heated the tube to 1300 F and quenched it in cold water. The chrome plate did not crack. The condition of the aluminum at a temperature over its melting point, is shown inside the tube.

This chrome plating developed by Tiarco is known as the Hardalume process, and is used for the hard-surfacing of aluminum and its alloys. Advantage of the process is that the chrome is plated on the aluminum directly without any intermediate metal. It is an electrolytic process, with the surface of the part first treated chemically to remove the oxides. Brass, copper, stainless steel, aluminum, all steels, Cal-rods, tool bits, band saws, files, flat iron bottoms, and titanium gears and pistons have been plated successfully. A 0.025 in. plating is possible without peeling.

The chrome plate has a C70-72 Rockwell hardness, and 1200-1300 Brinell. Tiarco claims that the bond between the chrome and the aluminum is the strongest ever attained, but that the chrome is ductile. Tests have shown that the chrome flows with the part when it is distorted. Plating of sharply defined parts, like letter and numeral characteristics on a printing plate, is possible, and Tiarco says that the process avoids "treeing".

Tiarco is now in the process of marketing its own files, saws, band saws, and cutting tools. With the chrome plating, the files are claimed to have at least twice the life of the conventional file. The company also announced it is working on a process which will permit the substitution of cold rolled steel for stainless steel.

TECHNICAL NEWS

THE GYRO-SERVO UNIT of the automatic pilot is installed in the fuselage of the plane behind the baggage compartment, but may be installed in the nose, depending upon the model of the plane. The unit occupies about 1.5 sq ft of floor space. In operation, the actual position of the aircraft is sensed by a turn-and-bank unit, and the pitch units of the gyro-horizon assembly, which is part of the gyro-servo assembly. The autopilot requires no warmup time.

Tubeless, Transistorless Automatic Pilot

The trend toward completely transistorized products in the electronic field has been reversed by the Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J., with an announcement of their tubeless and transistorless autopilot for light- and medium-weight (7500 lb and under) private and business aircraft. No larger than the size of a portable typewriter, the unit consists of a small control unit, a gyro-servo, and a turn-bank indicator.

The F-200 is a two-axis system for single engine planes having coordinated rudder and ailerons. Model F-300 is a three-axis system for single and multi-engine aircraft with separate rudder and aileron controls. Both models control heading, roll, and pitch through a relay-controlled servo system operating on the elevator, rudder, and ailerons. A mechanical feed-back system will prevent any overshoot. There is no overcorrection, and for increased safety, the pilot can override the autopilot anytime.

The gyro-servo (see photo) is the heart of the system, and contains a vertical gyro which senses the roll and pitch of the plane; electrical pickoffs which transmit this information; and actuators which move the control surfaces of the plane to maintain level flight. The actuators work through clutches having enough slippage to permit the pilot to override the unit at any time. A trim motor displaces the control surfaces to correct for fixed weight changes, which might be caused by a passenger changing seats.

The control unit, mounted beside the pilot's seat, permits a fixed angle climb and descent, climbing or gliding turns, and straight and level flying. The unit consists of manual "turn," "pitch," and "course trim" controls, two on-off "roll" and "pitch" switches. The turn-bank indicator senses any right and left deviation from the course, and sends the corrective information to a trim motor.

Power requirements are low. The F-200 draws a maximum of 7.2 amps at 12 v d-c, and the F-300 a maximum of 9.6 amperes.

The Future of Engineering Unions

"The trouble with engineers is that they want the benefits of collective bargaining without the hardships. They want to bargain with management and be part of management. This acute ambivalence has led to ineffectiveness." This was a remark of Dr. Benjamin Aaron, research economist of the Institute of Industrial Relations, of the University of California, in his talk to Engineers and Scientists of America at their 4th Annual Convention. Dr. Aaron's talk was, "The Future of Engineering Unions," which he said was "not impressive." The reason for this was the possible future rivalry with other groups seeking to represent engineers, which would be a test of the holding and growing power of the ESA. Another future problem is the increase in hiring rates for graduating engineers, which would necessarily lead to more leveling of engineering salaries. Dr. Aaron also said that engineering unions are at the crossroads, with two alternative paths: (1) Abandon ESA and depend on the professional societies and collective activities of the trade unions; or (2) Really become a union.

At the business meeting, a proposal that ESA seek affiliation with the AFL-CIO as an autonomous, nationwide union of engineering and scientific employees, was defeated by a rate of 46 to 4. The ESA also declined an invitation to merge with the Amerisan Federation of Technical Engineers, AFL-CIO.

Aircraft Lead Time Will Increase

The increasing complexity of the modern combat plane will probably lengthen the lead time for designing and producing new models. However, a survey made by the Aircraft Industries Association has shown that the lead time on fighter planes now in production is about the same as those for World War II models—4 years. Yet, there are production fighters today capable of speeds beyond 1,000 mph, compared with 400 mph of World War II aircraft.

Each major increase in performance produces new problems. A plane

that will perform at supersonic speeds must also perform at subsonic speeds. The number of wind tunnel hours for a Mach 2 plane is 10 times that required for subsonic aircraft. The man hours required for a supersonic fighter from design to first flight of the prototype was 690,000 compared with 230,000 for a fighter used in World War II. But its operational ceiling is 50,000 ft. compared to 30,000 for the older plane, and its speed is almost tripled. Performance and complexity are directly related. A Navy fighter in World War II required about 7,000 parts. A fighter plane today needs 25,000. Procurement time for these parts has increased. For engines, this time has increased from 33 weeks in 1950 to 53 weeks at the present time; for a combustion heater the time is up from 13 weeks in 1950 to 33 weeks.

The lead time for a heavy bomber is about 9 years from preliminary design to first flight. A World War II bomber weighed 66,000 lb., had a top speed of 350 mph, and required 30,000 parts exclusive of nuts, bolts, and rivets. A modern jet bomber weighs 350,000 lb., flies at 650 mph, and has 100,000 parts. Manufacturing tolerances also have been refined.

Briefs . . . .

General Electric says that its "man-made" diamonds are now being produced successfully in a pilot plant operation, and estimates that industrial diamonds could become a $200-million business within the next decade, if the cost of man-made diamonds can be brought down below those now being mined. Diamonds are now mined at a rate of about 2½ tons annually, primarily in Africa but with a smaller supply from South America. About 90 per cent are imported by the U.S., with major portion going for grinding, polishing, and cutting tools. The U.S. pays more than $50-million per year for industrial diamonds. Eighty per cent by weight of all the industrial diamonds used in the U.S. are of sizes that can be produced readily by G.E.'s new process. The first man-made diamonds are now on display in the Smithsonian Institute.

By July 1957, a 1,500,000 pound-per-year plant for producing reactor grade zirconium sponge will be in operation. Owners of the plant, U.S. Industrial Chemical Co., Div. of National Distillers Products Corp., 90 Park Ave., New York 16, N. Y., will sell the sponge for $7.00 per lb to commercial users, compared to the present price of $14.00. The plant will be located at U.S.I.'s sodium and chlorine plant at Ashtabula, Ohio, and will use both of these chemicals in the process. It will be the first semi-continuous process for making zirconium. The new technique developed by the company is said to be applicable to metals such as titanium, thorium, beryllium and hafnium. U.S.I. claims that the big advantage over the Kroll process used for producing zirconium is the lower initial investment necessary. U.S.I. will supply the government with 5-million pounds of reactor grade zirconium sponge over a five year period, which is a good portion of AEC's 11-million pound procurement program. For non-nuclear uses where halfnium does not have to be removed, U.S.I. will sell this commercial grade zirconium at $3.50 per pound.

According to an Air Force spokesman, the new Air Force heavy press program, incorporating the 50,000 and the 35,000 ton forging presses, will result in a saving of $13-million over alternate methods of fabrication. This figure was based on aircraft now on order for a particular model of a jet fighter.

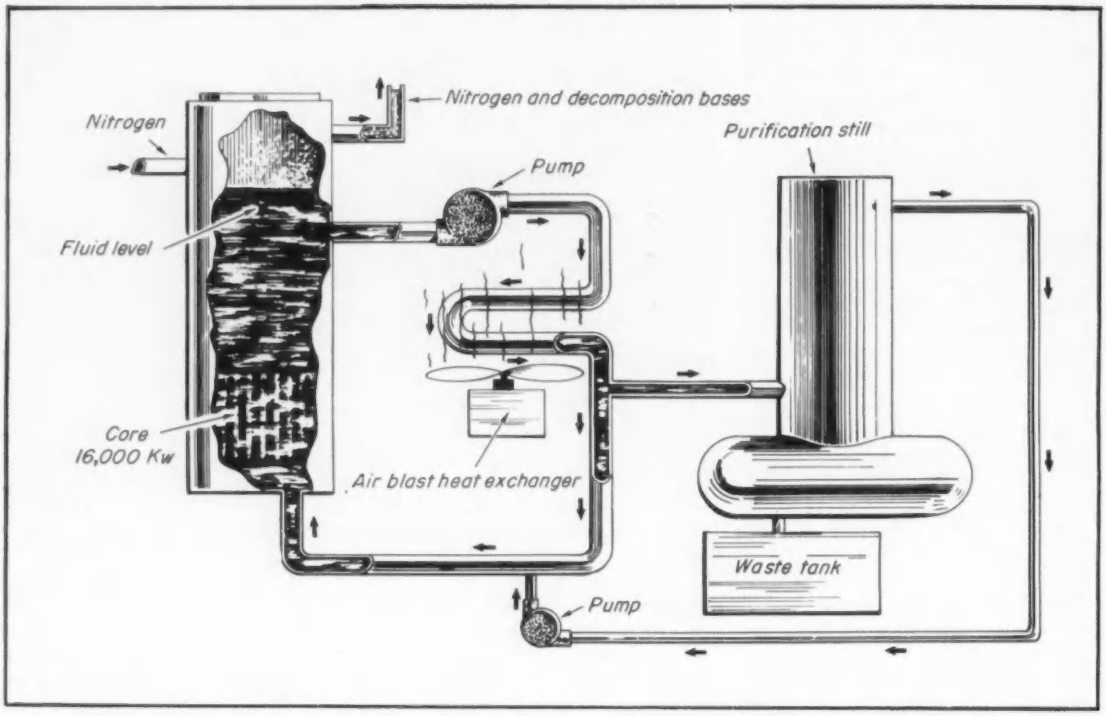
Four new foundry resins for coating the sand used in shell molding have been developed by the Monsanto Chemical Co., Springfield, Mass. Advantages of resin-coated sands are: improved flowability of the mix, elimination of dusting and pattern lubrication, and non-segregation of the resin and sand. Monsanto claims that the new sands will increase the number of applications of shell molding. Of the four resins, all phenolic formulations, one was developed specifically for hot coating, and that the other three are recommended for cold coating. Although all of the resins are adaptable to the production of shell molds and cores by blowing, two can be used for dumping.

The Engineers and Scientists of America (ESA), a federation of collective bargaining groups of engineers, is attempting to outlaw the Aircraft Industries Association's (AIA) so-called "Gentlemens' Agreement." The first step in this direction has been made by getting the U.S. Air Force to state that it had nothing to do with the "restrictive hiring practices followed by many aircraft firms" which form the AIA. The members of the AIA claim that they have been regarding the "gentlemens' agreement" as Air Force policy. This agreement, according to the ESA, is a resolution adopted by the aircraft manufacturers, by which they agree not to offer employment to employees of member companies of the AIA unless the member company agrees; and, a company cannot hire an engineer of a member company, if the engineer seeks the job himself, unless he has a release from his company, or remains unemployed for a period of 30 days. This agreement was made by the aircraft companies in an attempt to solve the problem of "pirating" of engineers that existed in that field.

The results of a recent National Science Foundation survey covering about 11,600 companies employing 554,000 scientists and engineers show that 28 per cent of them are engaged in research and development.

A 100 line, transistorized all-electronic dial telephone switchboard which uses no vacuum tubes or mechanical stepping switches has been developed by Stromberg-Carlson, Div. of General Dynamics Corp., for the Bureau of Ships. In this switchboard, all line feeding, circuit switching, tone signal generating, and other functions are performed by transistors or diodes. The 100 line, 15 link switching system was developed for shipboard use, requires 4500 transistors and 500 diodes, and will weigh about one-fourth as much and take less than one-half the space of a typical electro-mechanical dial system. The systems can be completely sealed, or sub-assemblies can be sealed in plug-in units.

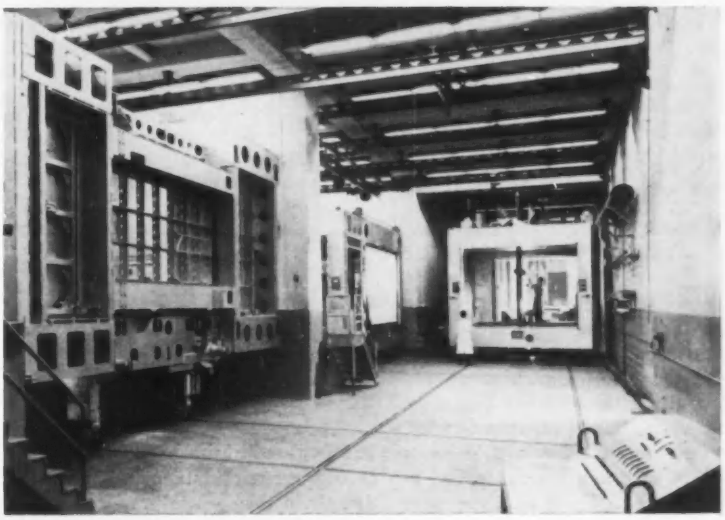
THE NEWS IN PICTURES



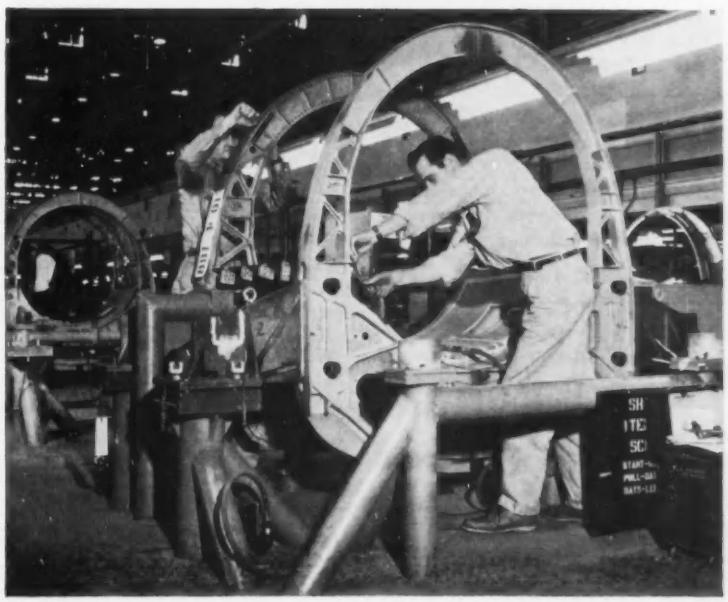
ANOTHER NUCLEAR REACTOR in which the Atomic Energy Commission is interested is the Organic Moderated type, shown here in a schematic diagram. Instead of using liquid sodium, liquid metal, heavy water, or light water as a heat transfer agent, the new reactor uses a carbon-hydrogen compound such as diphenyl. Advantages of this material as a coolant: its high boiling temperature, thus eliminating any high pressures; its negligible corrosion with standard materials; it does not react readily with uranium; and it becomes only slightly radioactive. The compound also serves as a good moderator and slows down the neutrons produced in the fission process to help sustain the chain reaction. Problems not yet solved concern the deterioration of the organic liquid caused by the heat and radiation. In illustration, still at right, purifies the diphenyl for re-use in the coolant system. Designer is North American Aviation, Inc.

TWO AMPEX CORP. ENGINEERS inspect the company's new device for recording and reproducing both the picture and sound of television programs on magnetic tape. The recorders will operate at only 15 in. per sec, and will give more than a full hour television program on a single 14 in. reel of 2 in. magnetic tape. Ampex claims a picture of better quality than kinescope techniques using photographic film. The ability to reproduce accurately all shades from black to white, is inherent in the system, and resolution of 320 lines is said to be better than the capability of the average television receiver. Economic advantages of the recorder are that programs can be recorded directly from the TV camera, from a TV receiver, television transmission line, or from microwave relay systems. It can be replayed immediately with no processing. The signal can be erased and the tap used again. Frequencies up to 4,000,000 cps are recorded by magnetic head assembly rotating at a high speed. This head actually consists of 4 heads on a rotating drum, with one head always in contact.

A MODEL OF A SEA PLANE HULL shows the spray pattern during a slow speed run at Convair's new 300 ft. towing basin in San Diego, California. Tests are conducted by suspending a model from a carriage which runs on a double overhead rail. The carriage is operated by a 30-hp constant-speed electric motor which drives three hydraulic pumps. Two low pressure pumps operate at 600 psi, while the other pump operating at 3000 psi, supplies the power for maximum acceleration. A stainless steel cable running the length of the overhead rail, and connected to a drum driven by the pumps, pulls the carriage, which in turn drives the model. The carriage is capable of accelerating to about 68 mph in 50 feet. Data recording equipment is mounted on the carriage.

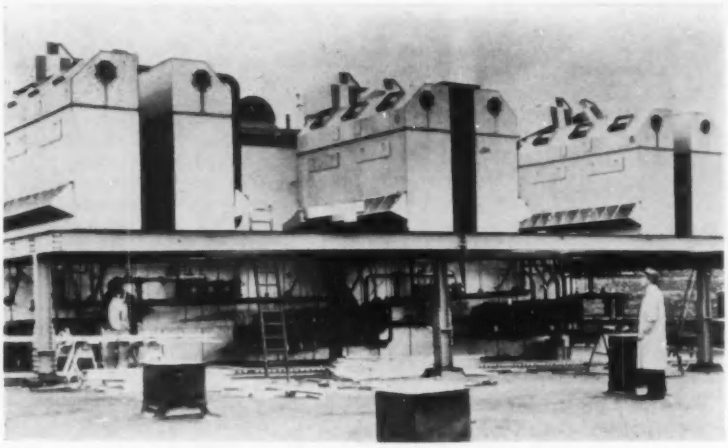


SUPERSONIC, TRANSONIC AND SUBSONIC self-propelled test sections are moved about at the Southern California Cooperative Wind Tunnel, recently dedicated after a 5-year, $8-million modernization program. Operated by the California Institute of Technology, the owner aircraft companies are: Convair, Douglas, Lockheed, McDonnell, and North American. Capacity of the tunnel is windstream of 1400 mph or Mach 1.8 velocity. So far a total of 25 aircraft and 15 missiles have been tested here. In addition to being mobile, the test sections can be equalized to atmospheric pressure while the rest of the tunnel is left at some other pressure. All test data is recorded, and a computing center located adjacent to the control room produces final data.



FUSELAGE BULKHEADS for the Convair F-102 A all-weather jet fighter are now being forged as part of the U. S. Air Force heavy press program. The fuselage forgings are interchangeable, right with left half, thus requiring only one set of dies for an effective savings in initial tooling outlay. A total of eight parts for the F-102 A are made from heavy press forgings. Early models of the plane used "blocker" forgings until heavy press forgings were available. Cost of the dies to make the fuselage bulkheads was amortized in machining savings over blocker-type forgings on the first few planes. The forgings are made for Convair by two of the companies engaged in the heavy press program: Wyman-Gordon Co., and Alcoa.

TECHNICAL NEWS



COMPLETELY AUTOMATIC CONTROLS handle all the temperature changes for the six York compound compression heat pumps shown here. In the winter the pumps serve as air coolers, and in the summer as evaporative condensers. The system automatically switches from a single stage compression to compound compression when the outside temperature drops below a specified point.

Heat Pump for Below Freezing Outside Temperatures

First announced by Lord Kelvin in 1852, the heat pump has been in the process of development ever since. More than 25 years ago, systems applying the heat pump principle, but with water as the source of heat, were used successfully. In recent years, the heat pump, using outside air as the heat source, has been applied to home heating. However, there were limitations to this system when the outside temperature fell below freezing, and supplementary heating systems were necessary.

The York Corp., of York, Pa., has solved this latter problem by applying the compound compression technique to its heat pump system. Advantages of this system are: 67 per cent more heat; and a 50 per cent reduction in electric power. The heat pump removes heat from zero degree outside air while cooling this air to still lower temperatures as it passes over the refrigerating coils. The heat removed is raised to a usable temperature in the compression cycle. This heat can be used to produce hot water, which can be circulated through the building, or the hot refrigeration can be used directly in the coils to provide forced warm air heating. During warm weather the system can be reversed.

The new Heironimus Department Store in Roanoke, Va., is using the new York system. All of the cooling and heating equipment is located in a penthouse on the store's roof. York announced that it is working on a smaller version, a system for use in the home, and expects to have one on the market next year.

More Manufacturing Training Needed

"About one out of every three mechanical and industrial engineering graduates is being assigned manufacturing responsibilities. Yet, the number of courses offered in this field in most universities today is inadequate to equip the graduate for responsibility in this field." These are the results of two surveys just completed by the National Education Committee of the American Society of Tool Engineers, and according to ASTE reveals a serious need for revision of presently offered university curricula. Returns from graduates of various schools showed that manufacturing was the most assigned activity, with product design, research, sales, and administration next. Heat and power were far behind in assigned activities. The results confirm a previous ASTE survey three years ago. This survey showed that of 142 engineering schools, only 36 offered 25 or more credit hours in production engineering, and several offered none.

New Lubricants for Temperature Up to 2000F

High temperature aircraft lubricants that will operate between 1000 and 2000 F are just around the corner, according to Dr. Donald Wilcock, manager of chemistry and metallurgy in General Electric's General Engineering Lab., and an authority on bearings and lubrication. Up to this time the upper temperature limits of silicone oils have been 700 F.

The new compounds, according to Dr. Wilcock, will flow at red heat, and will open up new fields of aircraft engine design. However, the characteristics of these compounds present another problem of freezing too quickly. Some of the compounds have such high boiling points that they will freeze at temperatures around 400 F.

ASME Sponsors Management Courses

With industrial management recognizing that managers must be developed from the ranks, and that properly trained engineers fit well into these positions, the ASME Management Division, of Southern California, has arranged for a management-consulting organization to conduct courses in engineering management. Because of the over-subscription to the first course in the two-year program which started last fall, the ASME has announced two new classes starting in May in Pasadena and Long Beach. All engineers in the Los Angeles area have been invited to participate in the program, and membership in the ASME is not required.

California industries are reported to have taken an interest in this management development approach, and some 45 companies have sent men ranging in level from Design Engineer to Vice President. Almost all engineering specialties are represented.

As the techniques are learned only

by doing, the group discussions are essential to this learning process. The training courses lean heavily on case-history study, role-playing, and small problem-solving groups. Discussion of the student's own problems in work situations is encouraged.

Spectrograph Plots Energy of Audio Signal

Just announced by the Naval Research Laboratory, Washington 25, D. C., is a sound spectrograph which presents an instantaneous plot of the energy of an audio signal. A permanent recording of the spectral analysis is made on a new type of chemically treated electro-sensitive paper. The time dimension is plotted along the length of the paper, the frequency plotted across the width, and the energy of individual frequency components is indicated by the density of the recorded marks.

The spectral analysis is performed by a group of 42 comb-type bandpass filters. These filters are of a passive LC design, and are both accurate and stable with respect to their frequency selectivity characteristics. The Navy already has used this for analyzing a variety of signals, and a second spectrograph is being considered.

Design Show Crowded On First Day

Philadelphia, May 14—At this writing, an hour and a half after the doors of Philadelphia's Convention Hall opened, the first Design Engineering Show unquestionably will be a huge success. With no pre-registration, more than 600 people were on hand at 9:30 am for the first technical session on Value Analysis in Product Design, presented by Messrs. A. D. Bentley and W. L. Healy, of General Electric Co. The ASME Machine Design Division, sponsors of the conferences, were surprised at the large turnout. Revising their estimates, they feel that tomorrow's session, How to Get and Train Engineers, should pack the house.

The exhibit floors will be opened at 12:30 today, after the technical session closing. Managers of the show, Clapp & Poliak, expect 12,000 people to visit the exhibits during the four-day duration of the Design Show.

COMING EVENTS

JUNE 11-15

National Plastics Exposition, of the Society of the Plastics Industry, Inc., the Coliseum, New York City. The latest plastics end-products and raw materials, new developments in machinery, equipment, tools, dies, molds, and manufacturing processes will be displayed. A Conference on Plastics will be held at the same time.

JUNE 14-16

Applied Mechanics Conference of the ASME, University of Illinois, Urbana, Ill.

JUNE 17-21

ASME Semi-Annual Meeting, Hotel Statler, Cleveland, Ohio.

JUNE 18-29

Special Summer Program in "Creative Engineering and Products Design," Massachusetts Institute of Technology, Cambridge 39, Mass. The program will present some of the techniques of creative problem solving. Full details and application blanks from the: Summer Session Office, Rm. 7-103, at the above address.

JUNE 25-27

Symposium on Methods, Materials and Processes involved in the uses of High Temperatures, co-sponsored by the Stanford Research Institute, and the University of California, at the University's campus in Berkeley, Calif.

High Temperature Symposium, Stanford Research Institute and the University of California at the latter's Berkeley, Calif. campus. Titled, "High Temperature—A Tool for the Future," it will be a 3-day symposium on the methods, materials and processes involved in the uses of high temperatures in science and industry. More than 300 scientific and industrial people are expected to attend. For further information, write: Dr. N. K. Hiester, Mgr., Chemical Engineering Section, Stanford Research Institute, Menlo Park, Calif.

JUNE 25-29

American Society of Engineering Education, Annual Meeting, Iowa State College, Ames, Iowa. For further information write to: W. Leighton Collins, University of Illinois, Urbana, Ill.

AUGUST 21-24

Western Electronic Show and Convention, 344 N. La Brea Ave., Los Angeles 36, Calif. Sponsored by the West Coast Electronic Manufacturers Association, and the Los Angeles and San Francisco Sections of the IRE. About 670 exhibitors are scheduled.

AUGUST 27-29

Association for Computing Machinery, University of California, Westwood Campus, Los Angeles, Calif. For information write: G. W. King, Box 3251, Olympic Station, Beverly Hills, Calif.

SEPTEMBER 10-15

Investment Casting Institute, University of Michigan, Ann Arbor, Mich. A six-day course in investment casting will provide members of the Institute with the latest technical data. Much of the information was developed through ICI technical committees.

SEPTEMBER 17-21

11th Annual Instrument-Automation Conference and Exhibit, New York Coliseum, New York City. Clinics, workshops and technical sessions will be conducted throughout the week program. Information on exhibit space can be obtained from Fred J. Tabery, Exhibit Mgr., 250 West 57th St., New York, N. Y.

SEPTEMBER 24-28

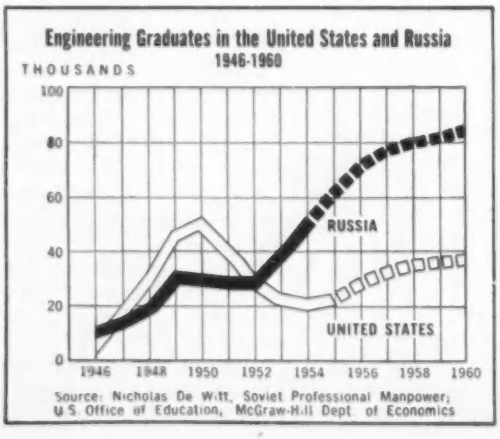
1956 Trade Fair of the Atomic Industry, Navy Pier, Chicago, Ill. Sponsor of the Fair is the Atomic Industrial Forum, and the Fair is being held in conjunction with the Forum's annual conference on "management and technology for the atomic industry." On view will be a wide range of products and services related to the atomic industry; its major components, auxiliary equipment, and many accessories. For further information write to the: Trade Fair Dept., Atomic Industrial Forum, 260 Madison Ave., New York 16, N. Y.

THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

Are We Losing the Race with Russia?

THERE is new confidence in the Kremlin. One key reason is expressed in a recent boast of Communist Party Secretary Khrushchev: **"The capitalists always regard our people as being backward, but today we have more engineers and more supporting engineering technical personnel than any capitalist country."** He promised that this lead would be widened and that communism would be victorious without war.

This boast cannot be dismissed as communist propaganda. Admiral Lewis L. Strauss, chairman of the U. S. Atomic Energy Commission, has warned: **"In five years our lead in the training of scientists and engineers may be wiped out, and in ten years we could be hopelessly outstripped. Unless immediate steps are taken to correct it, a situation, already dangerous, within less than a decade could become disastrous."**



This second editorial in a series on the shortage of scientists and engineers is designed to explore as carefully as possible the facts and the implications of the new emphasis on technical training in the Soviet Union. It draws heavily from the authoritative book *Soviet Professional Manpower*, prepared for the National Academy of Sciences and the National Research Council by Nicholas DeWitt of the Russian Research Center of Harvard and released recently by the National Science Foundation.

Trend Is Against Us

If the Soviet Union already has a lead in technical manpower, it is not very great. Both the United States and Russia now have around a million scientists and engineers. About a third of the Russian engineers were trained on inferior pre-1935 standards. **It's the trend — shown in the chart — that is alarming.**

Over the last five years we have turned out only 142,000 engineers, compared to an estimated 216,000 in Russia. In 1955 our output was around 23,000 compared to their 63,000. Over the next five years our projected output is 153,000, against at least 400,000 in Russia. There will be an additional 150,000 or more in the satellites and Red China.

In Russia, 30% of the college students are in engineering, compared to 8% here. Another 30% or more take degrees in natural sciences. Moreover, unlike ourselves, the Russians are

ploughing back a large proportion of their science graduates into teaching, which implies a rapid buildup in the future.

Quality As Well As Quantity

It would be foolhardy to assume that these new Russian graduates are inferior to ours in the quality of their technical training. They start out with much more intensive mathematical and scientific preparation at the high school level. They study harder and longer in college, with more laboratory work and more practical training. Their courses and textbooks seem to be as thorough as ours. Even though the Russian graduates may be overspecialized, they get results.

These results have been striking. The Russians developed both A-bombs and H-bombs faster than we expected, and it's not certain that they had to rely much on espionage. They pushed ahead of us for a while in jet fighter design, and they showed up with a fleet of long-range bombers well ahead of schedule. They are crowding us on nuclear power, electronics and automation. There are grave fears that they have established a lead in the vital field of military rockets.

The goal of Soviet scientific manpower policy includes not only weapon supremacy but also leadership of the neutral and uncommitted areas of Asia, Africa and the Middle East. The Soviet leaders may be bluffing in their offers to export capital, but they are preparing to export Russian scientific and technical know-how in a big way.

How They Do It

The Russians are determined to win the race for scientific supremacy, and they do not count the cost. **They pay their scientists and engineers salaries that seem fantastic when compared with other Soviet incomes.**

Senior professors, research scientists and top engineers are a major segment of the Russian elite. Their incomes are frequently six to ten times the average industrial wage. (In the U. S. six to ten times the average industrial wage would be $25,000 to $40,000 a year.) Housing and other privileges are correspondingly lavish. While preaching equality, the Soviets use capitalistic incentives far more boldly than we do. Indeed, practicing engineers and scientists have been complaining about the exalted status of professors and top research people, and salary scales are now being adjusted to give greater emphasis to practical results.

The Russians are also generous in their aids to education. Tuition has just been made free at all levels. Undergraduates receive 200 to 500 rubles a month and graduate students 800 rubles (about equal to an industrial wage) to cover living expenses. The biggest stipends go to science and engineering students. College students are deferred from military service, and engineers and scientists often enjoy continued deferment even after graduation.

Finally, the Soviet leaders can channel engineers and scientists — and all other human and material resources — into any area they choose. And the areas the Soviet leaders choose are predominantly those that contribute to military or political objectives, rather than to a better life for consumers.

What's Our Answer?

We are certainly not going to adopt Soviet methods. We do not want scientific robots, but free men, able to understand and add to our democratic heritage. At the same time, our world leadership in technology — and perhaps even our survival as a nation — will be threatened if we allow ourselves to lag far behind Russia in the training of scientists and engineers. Ways to keep the United States in the race will be discussed in a later editorial in this series.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

If you need to guard against overloads, it'll pay you to use

Adlake mercury relays

Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

For more information about Adlake Relays, write The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana

Adlake 99th year of serving the transportation building and control industries

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago
the *original* and largest manufacturers of mercury plunger-type relays

Screw-Holding Power of Polyester Laminates

Sheet metal can be attached to polyester-glass fiber laminates as thin as $\frac{1}{8}$ in. with sheet metal screws to give torque values exceeding 35 in. lb.

R. R. DIXON
Westinghouse Electric Corporation

RESULTS OF SCREW-HOLDING TESTS on seven $\frac{1}{8}$ in. laminated panels, Table I, led to the following conclusions:

(1)—Major variable is the size of the hole. For maximum torque, hole should be about 0.125 in. for No. 10 screws and about 0.100 in. for No. 8 screws. Larger holes give less contact area and smaller holes result in delamination and degradation when screw is driven.

(2)—Increasing glass content increased holding power.

(3)—Inert fillers reduce torque by about 4 in. lb.

(4)—Spiral mat showed no improvement over conventional chopped strand mat.

(5)—Chlorinated resins show some improvement.

The test data are summarized in Figs. 1 (A) and (B). Since these data were intended for commercial use, no attempt was made to determine the effects of variables such as temperature, humidity, and screw dimension. Screws were measured on the outside diameter and were rejected only if they did not fall within commercial tolerances. Screws were driven through the sheet metal which was simulated by a steel washer into the plastic. To correct for thickness variation between panels, torques as measured were corrected to 0.125 in. thickness, assuming that torque was proportional to material thickness. Holes in the plastic were drilled, using standard size drills.

Screws were driven with a torque screw driver. Stripping torque was the maximum torque attained, and where the screw-head deformed so that a stripping torque could not be obtained, the torque was plotted with an arrow indicating a value greater than the highest torque read. Plotted points are the averages of five readings.

Data from the seven tests are combined in Fig. 2 (A) and (B) as a function of hole diameter. It is apparent that hole diameter is the most important variable in the system since both curves go through a maximum above 35 in. lb, regardless of the laminate.

Table I—Composition of Laminates

MATERIAL	GLASS		RESIN	FILLER
	Percent Weight	Percent Volume	Weight, percent	
A	40	26	60	None
B	45.5	30	54.5	None
C	33.3	26	33.3	33.3 Surfex
D	33.3	26	33.3	33.3 Al $(OH)_3$
E	33.3 Spiral	26	33.3	33.3 Al $(OH)_3$
F	33.3	26	28.6 Cl plus 9.5 S	28.6 Al $(OH)_3$
G	33.3	26	35.2 Cl plus 3.5 S	28.0 Al $(OH)_3$

(continued on page 219)

New COMPO E®

BEARING MATERIAL

SAVES UP TO 40% ON BEARING COSTS • COMBINES THE ADVANTAGES OF BOTH BRONZE & IRON • SUPPLIES "BUILT-IN" LUBRICATION OF 23% BY VOLUME • INSTALLS AS EASILY AS HIGHER-PRICED BRONZE BEARINGS • OPERATES AT SHAFT SPEEDS UP TO 3500 RPM • AN EXCLUSIVE BOUND BROOK MATERIAL BACKED BY 73 YEARS' EXPERIENCE

write today for complete data

BOUND BROOK

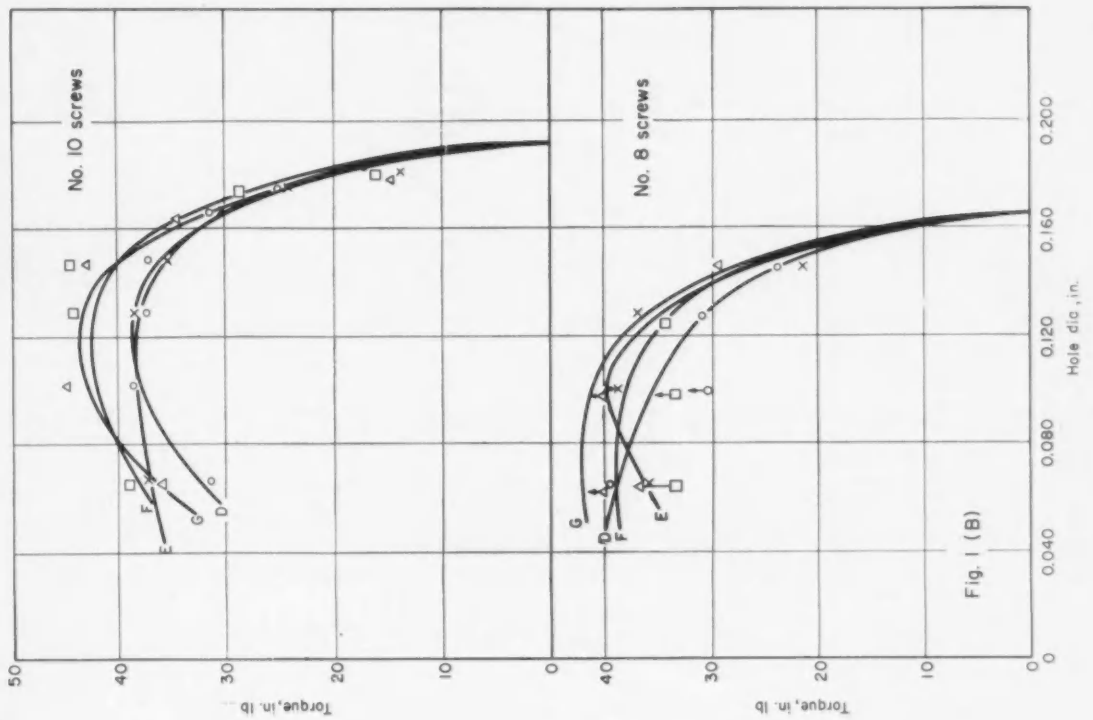
BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

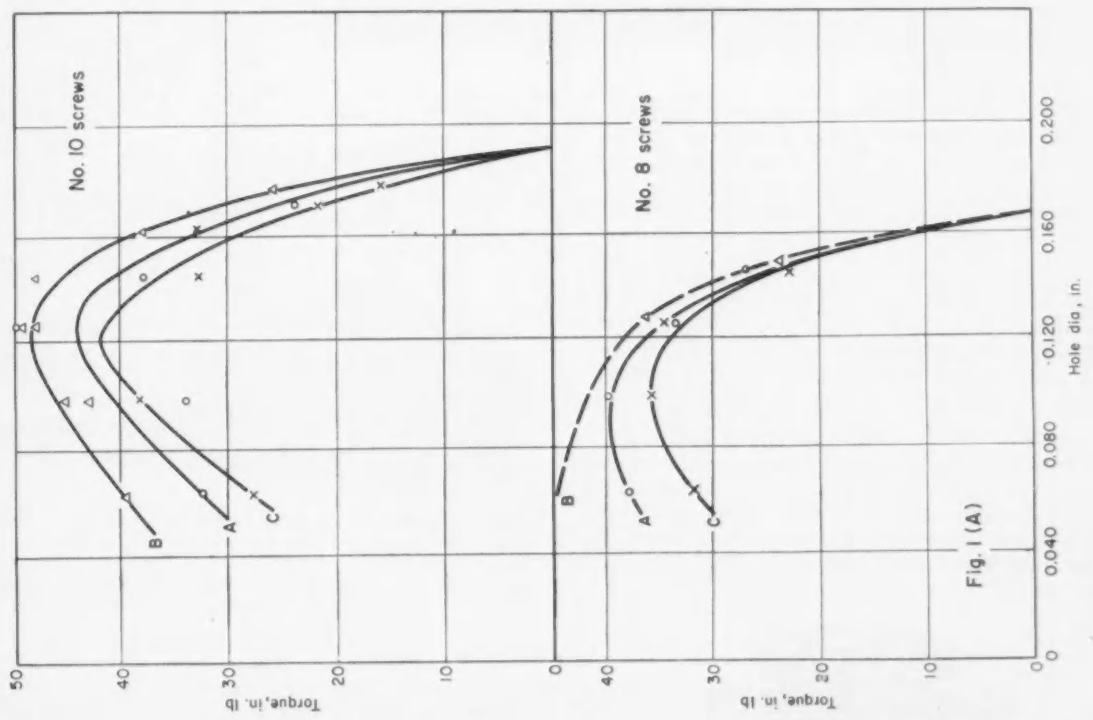
Pioneer in

POWDER METALLURGY BEARINGS + PARTS

PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Screw-Holding Power of Polyester Laminates (continued from page 217)

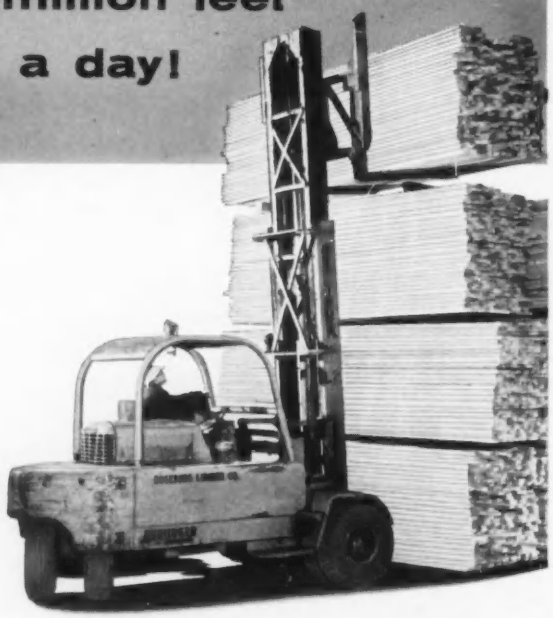




(continued on page 221)

Biggest single mill operator in the Northwest teams up with fast-working FORD POWER

. . . moves over 3 million feet of lumber a day!



Roseburg Lumber Company now relies 100% on Ford Power to keep its lumber production flowing smoothly. This is a real "Paul Bunyan" size order! For during every workday an average of 25 carloads of lumber and six carloads of plywood roll out of the Roseburg Mill.

Now active in every phase of this operation are seven Gerlinger SM-20 Material Carriers and three S-15 Lift Trucks—all Ford-powered. Since these durable, high-performing units took over, Roseburg has maintained peak production . . . increased handling efficiency . . . lowered handling costs.

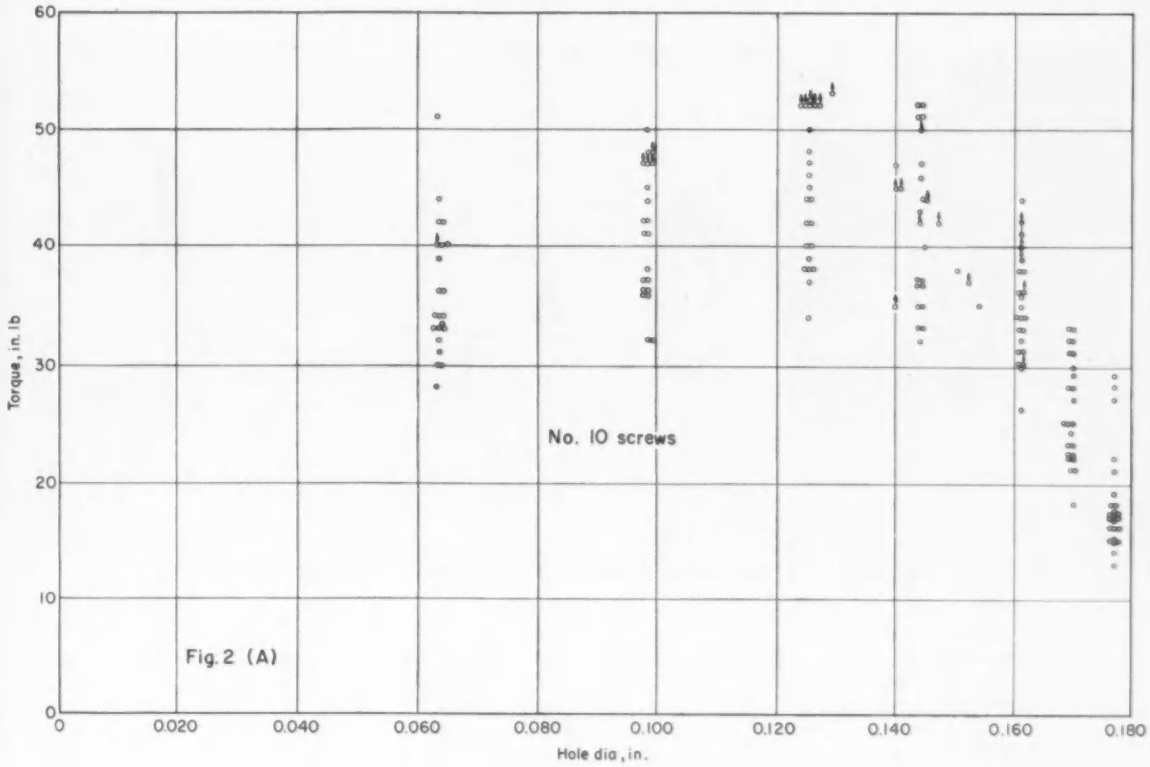
Couldn't *you* do better with modern, Ford-powered equipment on your job? Remember, to better serve industrial power users, a network of newly-appointed Ford Industrial Products Dealers has been set up across the country. Now there's a Ford Industrial Power Headquarters right in your own area.

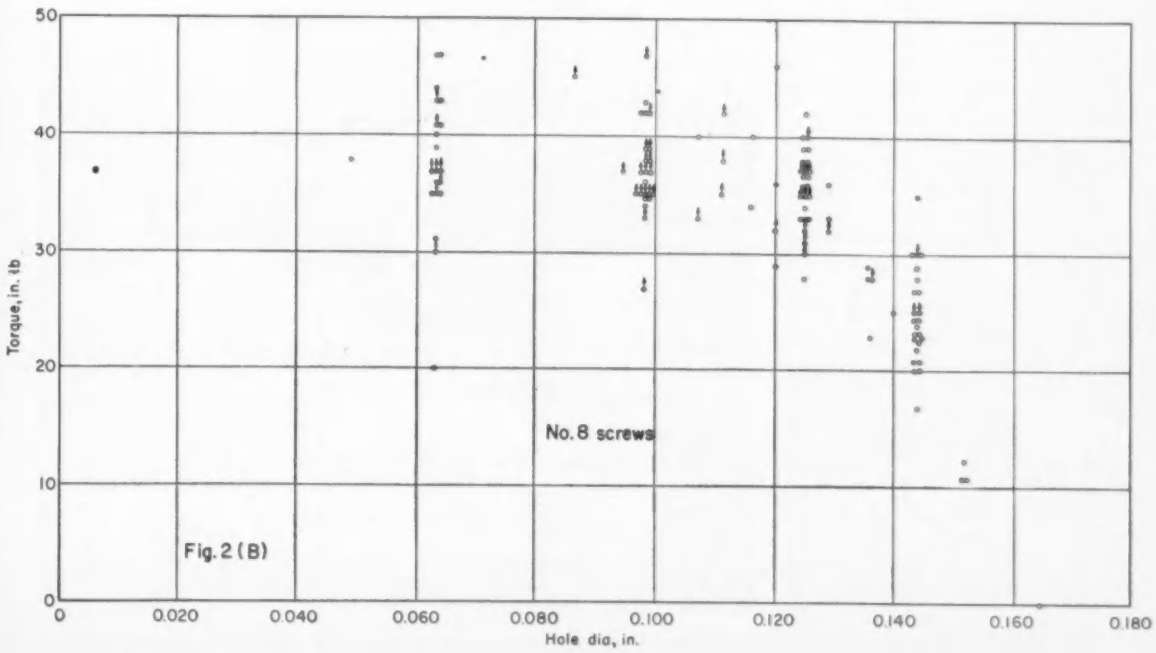
Ford
INDUSTRIAL ENGINES
AND POWER UNITS

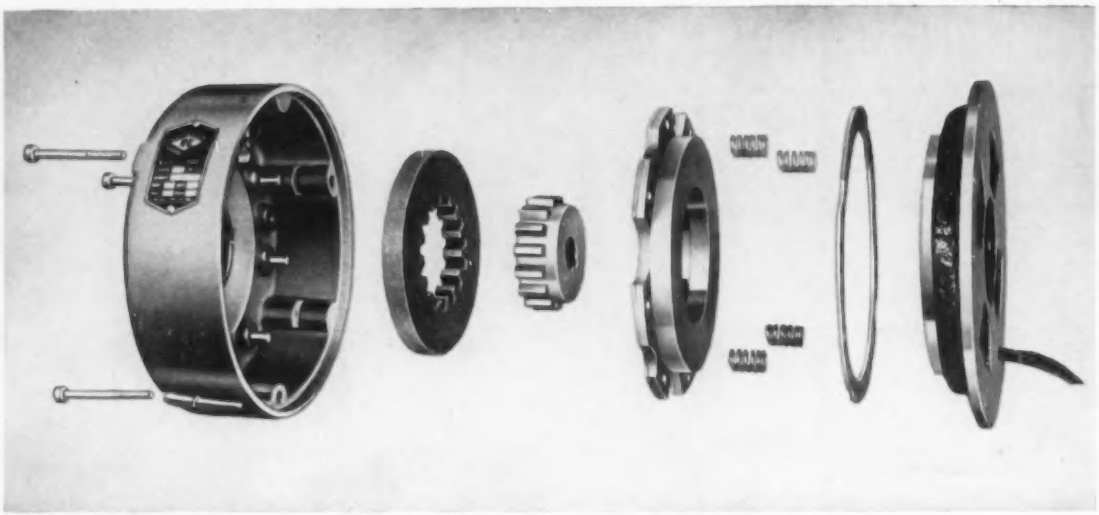
In one eight-hour shift, each Ford-powered Gerlinger Lift Truck can easily pile a half-million feet of lumber. These husky units have put in 24-hour days, six days a week for as long as eight months at a stretch—*without requiring one cent for extra engine maintenance.* No wonder Roseburg is 100% sold on Ford Power.

Phone or write for complete information:
INDUSTRIAL ENGINE DEPT.
FORD Division of FORD MOTOR COMPANY
P. O. BOX 598, DEARBORN, MICH.

Screw-Holding Power of Polyester Laminates (continued from page 219)





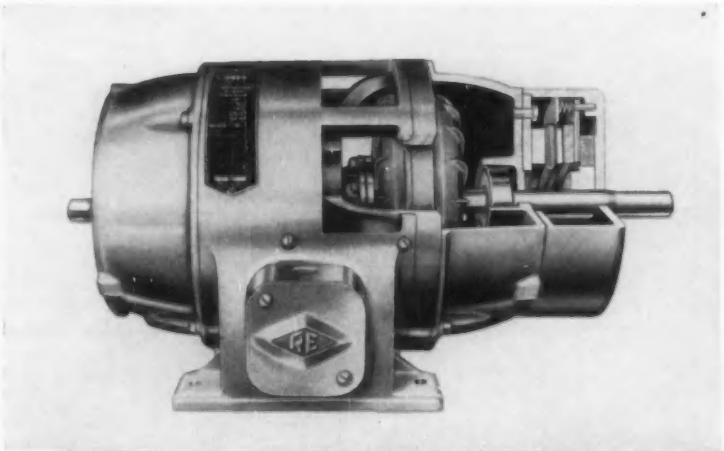


EXPLODED VIEW of complete disc brake, designed for motor output shaft mounting with minimum increase in length

Disc Brake for Fluid Coupling Motor

Development of a fluid coupling motor package confronted its manufacturer with the problem of providing a brake for many applications. The conventional front end motor mounting would not do as there was no solid shaft connection through the fluid coupling.

A direct-acting brake without linkage was the most feasible method of obtaining short length and a through shaft. To overcome the brake's spring tension, a "doughnut" coil was developed. The winding on this coil, according to the maker, is a true three-phase, star-connected winding and is wound and formed in much the same manner as a motor winding. This permits use of a relatively heavy wire which has high mechanical strength.



FLUID SHAFT MOTOR with brake on output end, cut away to show fluid coupling.

Iron core for this doughnut coil is made by running coil stock through a specially designed punch press, which cuts notches in the flat coil stock in constantly progressing increments. As the stock leaves the machine it is automatically rewound to the desired diameter. This machine produces a finished stator iron in which the slots are smooth and clear to accept the winding.

The armature is wound up from flat strip stock in the same way as the stator, but it requires no notching for a winding. These two surfaces of silicon steel wound on edge are relatively large for the forces involved. This is said to have resulted in a good life factor for the armature.

AND MATERIALS

SPECIFIED BY PRODUCT ENGINEERS

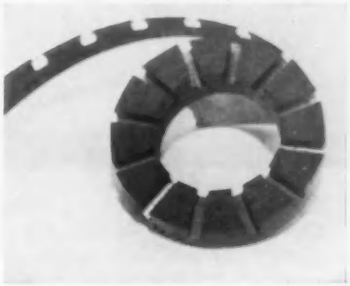
A heavy cast cover and braking surface was combined into a one-piece, weatherproof housing. By locating the friction disc against the cover maximum heat radiation was realized and heat build-up at the motor bearing was minimized.

The compression ring is slotted so that when it is correctly positioned the screws which hold the brake together prevent it from turning or working loose in the slot.

Direct action of the armature permits a brake with minimum movement between "set" and "open" positions. This in turn keeps the spring tension uniform and results in a constant torque, without readjustment, throughout the life of the lining.

This brake is available in torque ratings of 3 to 75 lb. ft. for both intermittent and continuous duty. All ratings are totally enclosed and in a weatherproof cast housing. A manual release is standard equipment. Any standard or special a-c voltage may be used at 25, 30, 50 or 60 cps. Reuland Electric Co., Alhambra, Calif.

For more information—
Circle 1, inside back cover

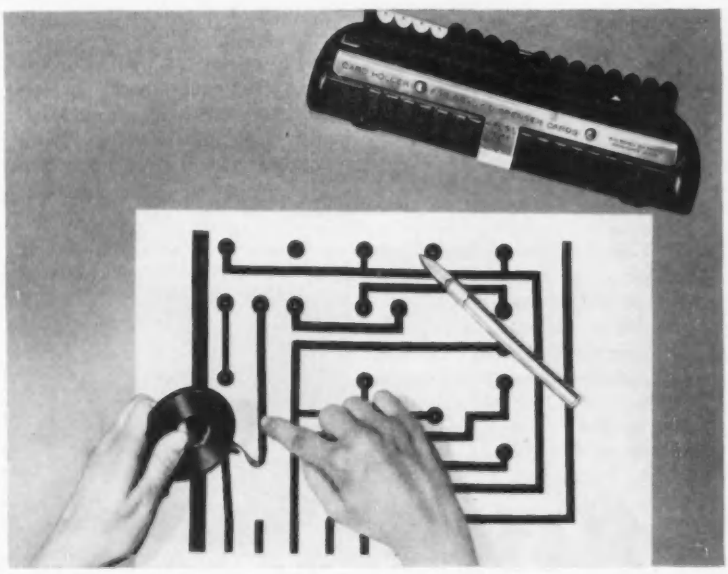


STRIP STOCK FOR IRON CORE is notched in the flat with progressively spaced notches which align to form slots for winding.

Printed Circuits With Self-Sticking Tape

Printed circuit master layouts and prototypes are made by using self-sticking narrow width tape for connecting paths and pre-cut terminal shapes. Ink, hand drawing and tracings are eliminated. To make a printed circuit layout on glass cloth or acetate, the draftsman positions the shapes and strips of tape on the board. Tape widths and terminal shapes used correspond with the "drawing" ratio. Most popular layouts are made up with a 4:1 and 5:1 ratio.

After the layout is completed, it is photographed, reduced down to proper size, and subjected to the usual photo-etching process involving copper clad laminates. The tape is jet black, photographs sharp and clear, will not reflect back into the camera. Because the tape backing is made from a crepe material, sufficient stretch is built into the tape to allow for curved paths.



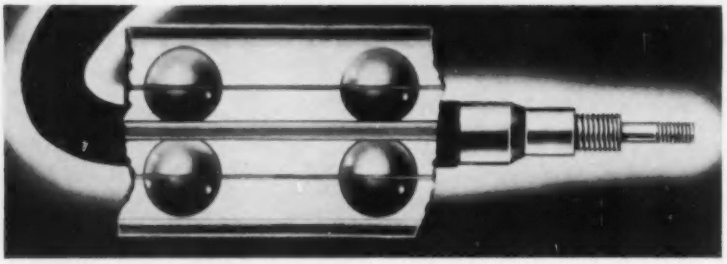
"Splash etch" prototypes can be made by laying out the circuit pattern directly on a copper-clad laminate. Copper clad sheet XXX (or thinner) is recommended for this technique. Rolls of narrow width tape 18 yd. long are available from stock in six widths: $\frac{1}{32}$, $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. Tolerances on width are ± 0.005 in. W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

For more information—
Circle 2, inside back cover

Ball-Bearing Remote Control

Roller bearings provide friction-free movements of a stainless steel blade in flexible tubing. This is said to permit layouts of far greater length and curvature, regardless of load. No lubrication is required. Operating efficiency remains relatively constant with input force variations or changes in layout conditions. Also since a solid steel blade transmits the load, backlash, especially after repeated cycling, is

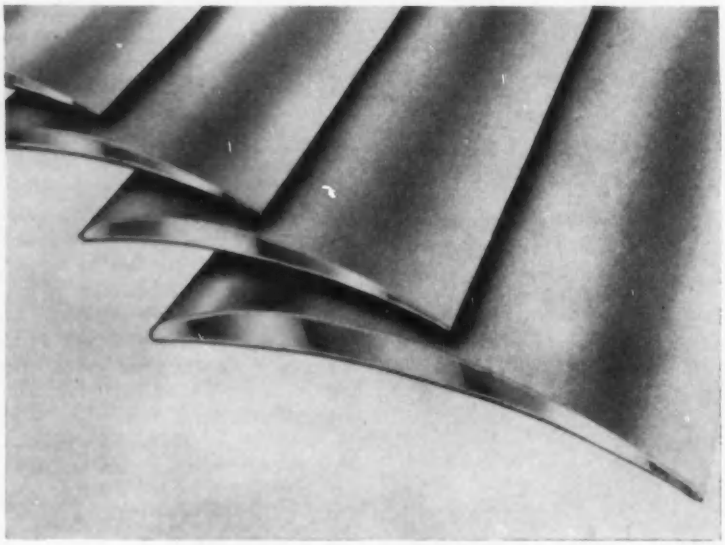
CONTINUED ON PAGE 224



held to a minimum under heavy loads.

Applications are indicated where excessively high and low temperatures prevent use of lubricated controls, where feasibility of using unlubricated heat-resistant alloys under excessively high temperature conditions is important. The device can manipulate loads up to 1000 lb., with a stroke up to 8 in. Controlex Corp. of America, Hangar 18, Westchester County Airport, White Plains, N. Y.

For more information—
Circle 3, inside back cover



Airfoil Shaped Strip

This precision, profile-rolled material is finding use as stator blades for the compressor section of jet engines. Also, there are many turbine type applications, such as hydraulic torque converters.

It is possible to meet exacting standards by surface finishing the stock after it has been rolled, according to the manufacturer. Vane strip can be supplied in the as-rolled condition, surface-polished, or finish-buffed. Rolled airfoil strip is available in continuous coils, random lengths, and straight lengths (stretcher leveled up to 6 ft.). Widths 1.5 in., ±0.006 in. and 2.5 in., ±0.009 in.; thicknesses up to 0.300 in. General Plate Div., Metals & Controls Corp., Attleboro, Mass.

For more information—
Circle 4, inside back cover

Decorative Cast Acrylic Sheet

A pearlescent cast acrylic sheet which is expected to find wide application in automotive and refrigerator nameplates and medallions, emblems, appliance knobs and placques is composed of natural mother-of-pearl diffused through acrylic sheet by a special casting process. Excellent orientation and color penetration of the component pearl is said to be achieved.

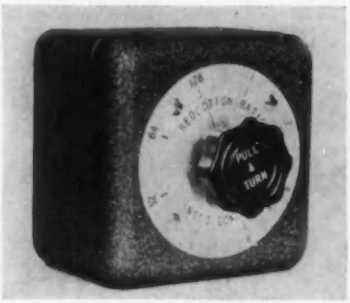
The cast pearl sheet is available in 20 jewelled and metallic colors, in thickness from 0.080 to 0.250 in. Standard sheet sizes range from 12 x 48 in. to 36 x 48 in. The sheet is easily machined and formed, without affecting the orientation of the component pearl. It is a thermal and dielectric insulator. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

For more information—
Circle 5, inside back cover

Step-Function Speed Reductor

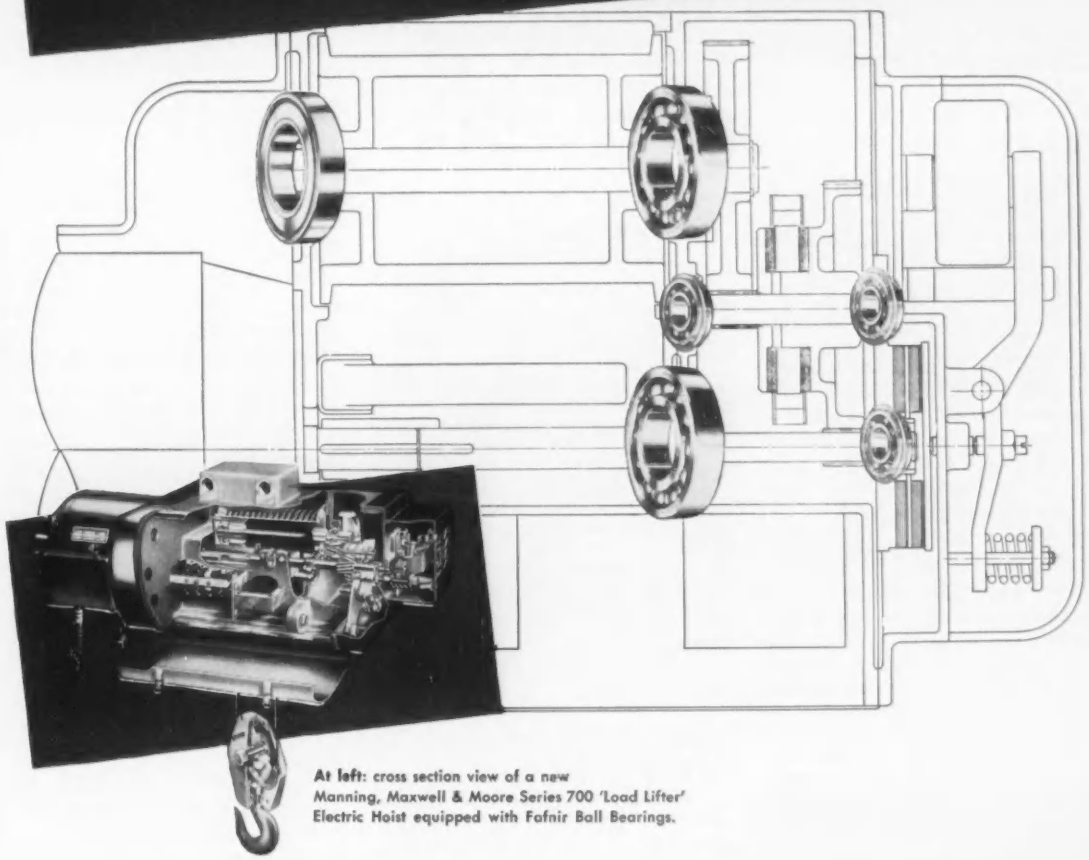
This Step-Function Speed reducer is described as combining the versatility of a continuously variable speed drive with the positive drive and exact repeatability of a geared unit. Any one of eight different speed ratios may be dialed by rotating the selector knob, which may be done without stopping the input drive shaft.

Unit has torque capacity in excess of 30 in.-oz and is recommended for input speeds up to 500 rpm. Reduction ratios up to 1500:1 are available with a variety of intermediate step increments. The reducer measures



CONTINUED ON PAGE 226

How an "Industrial Muscle" is kept from getting "Muscle-bound"



At left: cross section view of a new Manning, Maxwell & Moore Series 700 'Load Lifter' Electric Hoist equipped with Fafnir Ball Bearings.

Every bearing indicated in the diagram above highlights the strategy of Manning, Maxwell & Moore's electric hoist designers. Each eliminates a possible source of trouble caused by friction... on rope drum (bearing lubricated for life) on trolley assembly, on gear shafts, etc.

With critical turning points protected, this heavy-duty 1-ton capacity hoist is offered for three-shift lifting *every day in the year.* It lifts a ton, thirty feet a minute. Power is concentrated on lifting, not shared to overcome friction. It's smooth, steady, and efficient. Lubrication becomes a minor detail.

Fafnir is a supplier of Ball Bearings for Manning, Maxwell & Moore hoists and for hundreds of other industrial machines where Ball Bearing advantages improve performance and prolong service-life. The choice of Fafnir Ball Bearings, in case after case, has been influenced by the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, an aptitude for supplying the right ball bearing to fit the need. Maybe these attributes can help you solve a bearing problem. The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR **BALL BEARINGS**

MOST COMPLETE LINE IN AMERICA

4 x 4 x 3 in. Parallel ¼ in. shafts are on 2½ in. centers and models are available with shafts in line. It may be panel or base-mounted. Insco Co., Div. of Barry Controls Inc., Groton, Mass.

For more information—
Circle 6, inside back cover

Multiple Color Spray Enamel

A spray enamel which permits the application of two or more colors simultaneously from a single spray gun has been developed for the industrial products and commercial finishing fields. This finish is applied with standard spray equipment and spray techniques. It is available in a range of color combinations and, according to the manufacturer, the enamel offers excellent coverage over surface irregularities, a high degree of mar resistance, and extreme washability.

The multi-color coating adheres well to metal, wood, plywood, ceramics, stucco, plaster, wallboard, brick and building block. Due to chemical suspension, the various colors remain separated during the spray process, resulting in a speckled finish. Glidden Co., Cleveland, Ohio.

For more information—
Circle 7, inside back cover

High-Strength PVC Pipe

Impact strength is as high as 2.5 (izod), and the material remains tough and non-brittle at sub-zero temperatures. This pipe is resistant to weather and aging, as well as electrolytic corrosion, fungus, bacteria, and is non-toxic, inert, odorless and tasteless.

Pipe and fittings are now available in sizes from ½ to 2 in., standard or extra heavy wall construction (schedules 40 and 80 IPS.) Working pressure of the ½ in. extra heavy pipe is 490 psi, and that of the 2 in. extra heavy pipe is 255 psi, at 70 F. American Hard Rubber Co., 93 Worth St., New York 13, N. Y.

For more information—
Circle 8, inside back cover

Rectangular Meter

Metal cases will not chip, shatter or warp, and give anti-magnetic shielding to the meter movement. Accuracy of 2 per cent full-scale calibration (which is really calibrated to 1 per cent of full-scale deflection with controlled, certified standards). The meters are equipped with insulated zero adjustments that are safer and easier to use. The scales are large and clear so that they can be read at 8 ft. Phaostron Instrument & Electronic Co., 151 Pasadena Ave., S. Pasadena, Calif.

For more information—
Circle 9, inside back cover

Rotary Segmented Switches and Drums

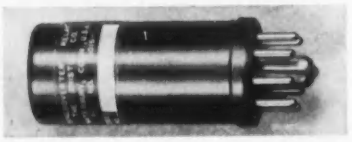
Designed for use in analogue-to-digital converters, shaft-position-to-digital converters, these rotary switches are expected to have applications in digital controls and read-outs, machine controls and pulse code systems. Drums are available in unambiguous natural binary, cyclical binary, binary coded decimal, and gray code. All other outputs, codes, or arbitrary linear or logarithmic functions are feasible.

Metal segments are diamond turned absolutely flush with plastic to a 2-4 micro-in. finish producing imperceptible brush bounce and make-and-break arc. Airflyte Electronics Co., 535 Ave. A, P. O. Box 207, Bayonne, N. J.

For more information—
Circle 10, inside back cover

High-Speed Relay

Designed for reliability in dry-circuit and low-power applications, operation of the relay is unaffected during shock of 30G, and vibration (10-55 cps) of 10G. Typical performance characteristics include: temperature range, −55 to 100 C; contact ratings, up to 28 v, 200 ma; pull-in time (including bounce), as low as 200 microsec; drop-out time, 300 microsec;



stray contact capacitance, less than 15 mmfd. Under these conditions, life expectancy is said to be at least 1000 hr at 400 operations per second. Bristol Co., Waterbury 20, Conn.

For more information—
Circle 11, inside back cover

Electric Motors With Extruded Insulation

Available in standard sizes from 1 to 40 hp, motors are said to be the first in this range of sizes with extruded plastic insulation. The present line is built in the open type frame and torque design B. They comply with NEMA specifications.

The thermo-setting plastic insulation, unlike conventional varnish insulation which is applied by dipping, is molded into and around the stator windings. Extensive field tests of the insulation have demonstrated exceptional resistance to chemical action, humidity, abrasive dust, lint, and oil

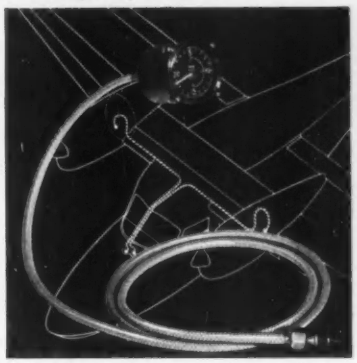
CONTINUED ON PAGE 228

FLEXIBLE SHAFT IDEAS for ENGINEERS

Gain extra design freedom... create cost-saving opportunities with S.S.White flexible shafts

S.S.White "Metal Muscles"® are readily adaptable to a wide range of space, operating and service requirements

BY USING S.S.WHITE FLEXIBLE SHAFTS to transmit power or control between two points, many of the restrictions placed on a design by rigid connections can be quickly removed.



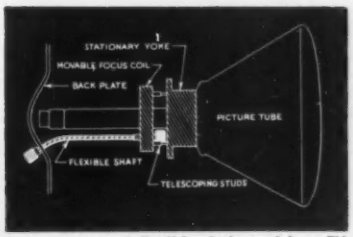
A flexible shaft tachometer drive application.

Save time and costs

Power sources and driven members or controlled parts and their controls can be positioned to better advantage. Costly methods of connection and adapting can be eliminated and general overall design can be improved. And, because an S.S.White flexible shaft does away with alignment problems and reduces the number of parts required for a control or power drive, costly and time-consuming assembly operations can be avoided.

Early consideration best

By far the best time to consider using S.S.White flexible shafts is when your product is still in the design stage. Then you can use them to maximum advantage and will also have a wider selection of shaft sizes, styles and characteristics to choose from than if your design is "locked up."

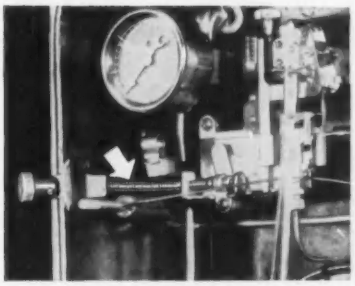


A remote control flexible shaft used in a TV-focusing device.

Satisfaction assured

Once selected, you can always count on S.S.White flexible shafts to measure up to the requirements of your application. S.S.White's many design and manufacturing developments have made S.S.White flexible shafts first in the field for quality, performance and dependability. Experience has shown that when it comes to flexible shafts you'll always be right – if you specify "S.S.WHITE".

"Coupling"... a money-saving flexible shaft idea



SHORT LENGTHS of S.S.White Flexible Shafting, used to "couple" two adjacent parts within the confines of a piece of equipment are a simple economical answer to many power drive and control problems.

Only a single length of shafting is needed regardless of *the relative position of the parts.* The shaft functions satisfactorily without vibration even under conditions of misalignment, thereby insuring trouble-free service and simplifying assembly operations. A typical flexible shaft coupling application is shown above.

Engineering cooperation on flexible shaft application problems

PROPER SELECTION AND APPLICATION *are essential if you are to get the most out of a flexible shaft. The services of our engineers – long experienced in solving all types of flexible shaft problems – are available for this purpose. May we cooperate with you on a specific current problem? There's no obligation. It will save you time and trouble.*

A "must" for every design engineer

Bulletin 5601 contains the latest information on flexible shafts, tells how to select and apply them. Send for your copy today.

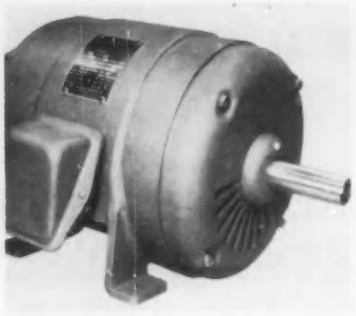
F6-5

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. D, 10 EAST 40th ST., NEW YORK 16, N.Y.

Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.



vapor. In applications that formerly required a totally enclosed frame, the motor has performed much longer than the totally enclosed motor it replaced. Lincoln Electric Co., Cleveland 17, Ohio.

For more information—
Circle 12, inside back cover

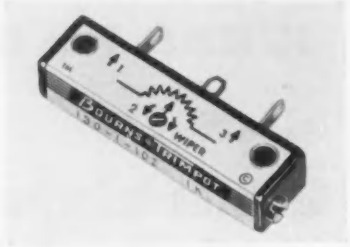
Four-Way Selector Valve

A solenoid-operated, two-position valve provides flow control of air, oil, gas or other semi-lubricating fluids at pressures up to 600 psi. The valve has a variable flow pattern, high-speed operation, long service life, packless construction and design which permits operation in any position. General Controls, Skokie, Ill.

For more information—
Circle 13, inside back cover

Subminiature Potentiometer

This trimming potentiometer is equipped with solder-lug instead of the usual wire leads. Designed for use where wire-to-wire splicing is not convenient or practical, it permits wiring direct to the instrument, using



simple soldering, or dip-soldering techniques. The terminals are extremely durable, and can be bent at right angles to the body to further simplify installation. This instrument has 98 per cent usable potentiometer range, and is screwdriver adjusted over 25 turns. Available in eleven standard resistances from 10 to 20,000 ohm, in resolutions ranging from 2.0 to 0.02 per cent. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

For more information—
Circle 14, inside back cover

Sub-Miniature Encapsulated Resistor

Measures 0.150 x $\frac{3}{8}$ in. length. A method of mechanically attaching the axial leads to the winding form eliminates the possibility of leads being pulled out during use. Values up to 500,000 ohm are available with tolerance as close as 0.01 per cent. Resistor will dissipate 0.1 w at 125 C without derating. Eastern Precision Resistor Corp. 677 Barbey St., Brooklyn, N. Y.

For more information—
Circle 15, inside back cover

Miniature D-c Motor

This miniature wound field motor can be wound shunt, series or split series. The outside diameter is $1\frac{1}{2}$ by $1\frac{3}{4}$ in. max. This unit can produce up to 1/200 hp continuous duty and 1/75 hp at intermittent duty. Series and split series motors can be wound for 115 v dc operation. The shunt motor can be wound for 70 v dc. The split series motor is primarily used where reversibility is desired with a single pole, double throw switch. The

series motor is somewhat more efficient and is used where starting torques and moderate current is needed. The shunt motor is used where better speed regulation is required. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 16, inside back cover

Waterproof Footswitch

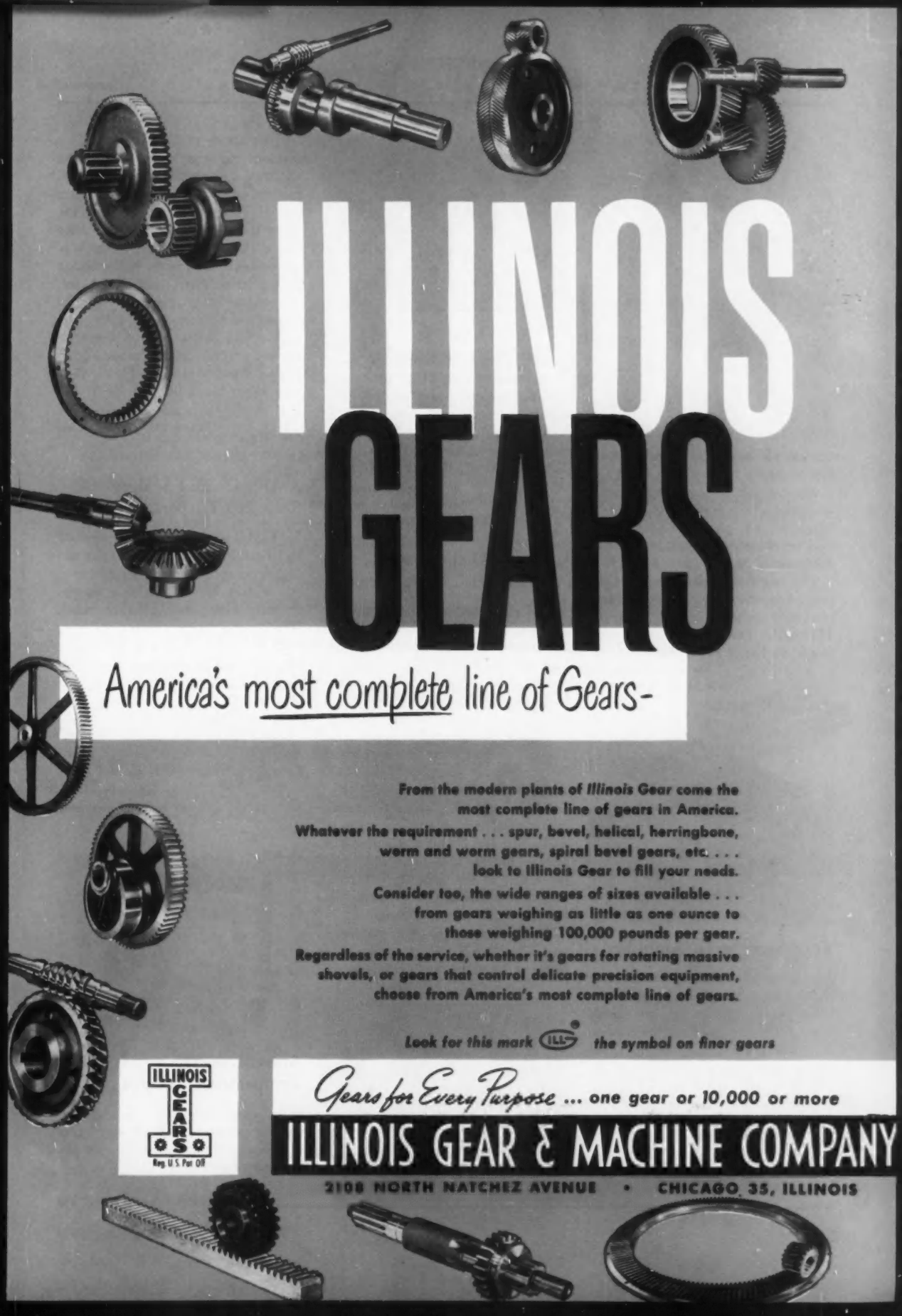
The switch is not only waterproof, but also dustproof, oilproof and rustproof. It is supplied in two models: WP 541-S with a rating of 20 amp 125-250 v ac, with momentary contact, single-pole, double-throw; and WP 541-D with a rating of 12 amp 125 v ac, 6 amp 250 v ac, with maintained contact single-pole, double-throw. The switch is 8 x 4 x $2\frac{1}{4}$ in. in size and weighs 2 lb $8\frac{1}{2}$ oz. Linemaster Switch Corp., 432 Woodstock Ter., Woodstock, Conn.

For more information—
Circle 17, inside back cover

Waterproof Snap Switch

Enclosed in a silicone rubber overmold, the unit is protected from water, oils, chemicals, dust, and will

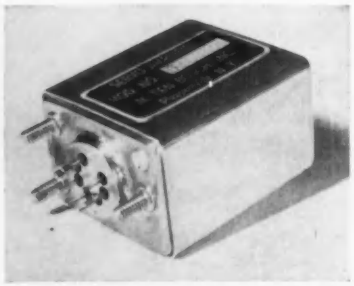
CONTINUED ON PAGE 230


ILLINOIS
GEARS
America's most complete line of Gears-
From the modern plants of Illinois Gear come the most complete line of gears in America.
Whatever the requirement . . . spur, bevel, helical, herringbone, worm and worm gears, spiral bevel gears, etc. . . . look to Illinois Gear to fill your needs.
Consider too, the wide ranges of sizes available . . . from gears weighing as little as one ounce to those weighing 100,000 pounds per gear.
Regardless of the service, whether it's gears for rotating massive shovels, or gears that control delicate precision equipment, choose from America's most complete line of gears.
Look for this mark ILG the symbol on finer gears
ILLINOIS GEARS
Reg. U.S. Pat. Off.
Gears for Every Purpose ... one gear or 10,000 or more
ILLINOIS GEAR & MACHINE COMPANY
2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

operate accurately at temperatures as low as −65 F or as high as 250 F. It is also available with neoprene or vinyl overmold where ambient temperature ranges are not great and where abrasion resistance or lower costs are the determining factors.

The switch is available with single-pole single-throw or single-pole double-throw switch action. Spencer Thermostat Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.

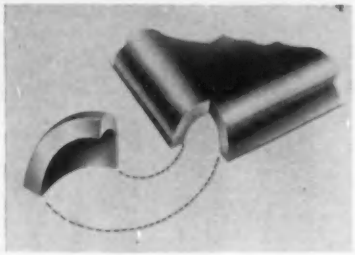
For more information—
Circle 18, inside back cover



Transistor Servo Amplifier

This is a miniature, hermetically sealed, plug-in amplifier which is primarily intended to receive signals from a synchro control transformer. It is $1\frac{7}{16}$ x $1\frac{11}{16}$ x $2\frac{7}{16}$ in. high and weighs 4 oz. Input impedance is 20,000 ohm, and output is 19.5 v max at 400 cps. Power requirement: 28 v dc, at 150 ma. M. Ten Bosch, Inc., Pleasantville, N. Y.

For more information—
Circle 19, inside back cover



Spherical Corners

Spherical corners furnished in metal thicknesses ranging from $\frac{1}{8}$ to $\frac{1}{2}$ in. can be welded into place on weldments having round edges, such as machine tables, housings, drip pans, panels. Conner Steel Products, 24690 Telegraph Road, Detroit 19, Mich.

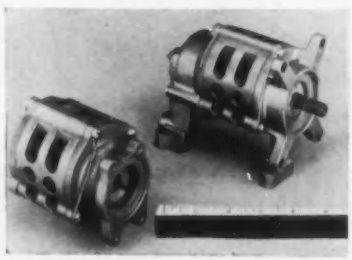
For more information—
Circle 20, inside back cover

Constant Displacement Air Motor

The air motor is of a constant displacement rotary vane design. With the exception of the blades and bearings, the motor is fabricated entirely of aluminum. The basic motor weighs $1\frac{1}{2}$ lb and develops $2\frac{3}{4}$ hp per 100 psi of inlet pressure. It will perform satisfactorily with inlet pressure of 300 psi. Overall efficiency approaches 70 per cent at speeds between 3000 and 6000 rpm.

Motor has been qualified for missile applications over an ambient range of −20 F to 160 F and accelerations of 60 G. Recent tests have illustrated the ability of the motor to withstand inlet gas temperatures in excess of 1000 F for as long as 2 min.

The motor on the right contains a unique governor which maintains a constant speed within 2 per cent for load transients of 10 per cent. This governor regulates motor speed from regulated inlet pressures of 300 to 600 psi without the use of a reference spring. This latter feature permits the use of this motor with a 1000 F power source. Upon application of the supply pressure this motor will stabilize at regulated speed within 0.2 sec. This motor with its governor is used to run an alternator, while the one at the left, without a governor, is presently used for hydraulic drive. Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.



For more information—
Circle 21, inside back cover

Anti-Seize and Sealing Colloidal Dispersion

This ready-to-use paste of semi-colloidal graphite in a special carrier was developed specifically as an anti-sieze and sealant for high-pressure oxygen systems, where line pressures reach 2000 psi at temperatures ranging from −65 F to 160 F. It is completely non-inflammable, even in the presence of high-pressure oxygen at temperatures of 575 F and higher.

The dispersion is available in 4 oz tubes, 2 lb jars, 13 and 65 lb pails, and 390 lb drums. Acheson Colloids Co., Port Huron, Mich.

For more information—
Circle 22, inside back cover

Automatic Temperature Control

An automatic indicating and controlling pyrometer for use with chromel-alumel, iron-constantin, and platinum-10 per cent rhodium ther-

CONTINUED ON PAGE 232

MAKE IT WEIGH LESS

N-A-X

HIGH-TENSILE STEEL

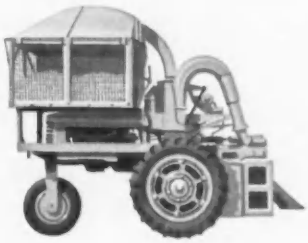
MAKE IT LAST LONGER

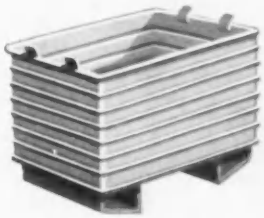
You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

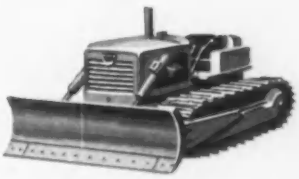
- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel – it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel – long recognized specialists in flat-rolled steel products.







N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

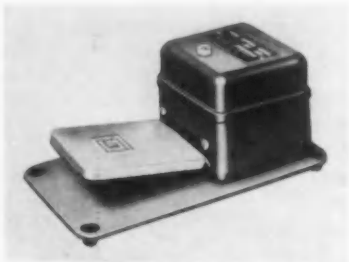
Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

mocouples operates on a photo-electric principle, eleminating moving parts and contact wear. A beam of light, directed at the mirrored meter face, is interrupted by the pyrometer needle to actuate a simple control circuit.

The controller, it is asserted, can be set for automatic continuous maintenance of a desired temperature within ½ per cent limits. It can also be set as a limiting controller, shutting off the heating device when the desired temperature is reached. Portable units are available, as well as models for panel mounting. It can handle loads up to 15 amp directly and is available for either 110 or 220 v ac. Jelrus Co., 136 W 52 St., New York, N. Y.

For more information—
Circle 23, inside back cover



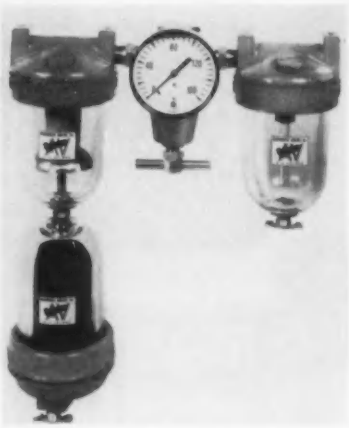
Light Duty Foot Switch

Applications range from controlling home workshop equipment to small industrial machine tools. The two-pole device with double-break contacts can be used to control a 1 hp motor at 110 or 220 v ac. Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

For more information—
Circle 24, inside back cover

Filters, Regulates, Lubricates Air

This air control assembly automatically filters, regulates and lubricates compressed air used in the operation of pneumatic equipment. Sludge, formed of dirt, scale, rust and moisture is automatically trapped by the



filter. This sludge causes corrosion and excessive wear to precision parts of air-operated equipment. An automatic drain tap attached to the bottom of the filter collects moisture from the filter, eliminating periodic draining maintenance.

After the cleaned air is regulated to the desired pressure, a fine oil mist is added by the lubricator, and lubricated air is carried to the operating parts of the equipment. Airmatic Valve, Inc., 7317 Associate Avenue, Cleveland 9, Ohio.

For more information—
Circle 25, inside back cover

Continuous Rotation Potentiometer

Linearity of this ten-turn unit is 0.005 per cent. Extended frequency limits are without phase shift. The potentiometer makes use of a double Kelvin-Varley circuit which is arranged to give a continuous, precisely linear voltage division. The device depends on matched resistors instead of a helical coil for linearity. It is available in a 5 or 10-turn model with or without centertap and also a special servo model which allows 180 deg overtravel on each end to prevent overshoot or sticking at the end of travel. The case size is 2 x 2¼ in. long. Servonics, Inc., 834 N. Henry St., Alexandria, Va.

For more information—
Circle 26, inside back cover

Gear Head for Size 8 Motors

A subminiature precision gear head weighs 1⅛ oz and measures 0.750 in. dia, and, in its "solid type" model, is 1 in. long. Four through-bolts make it adaptable to specially tapped Size 8 motors without the use of adapter plates or other accessories.

ABEC Class 5 ball bearings are used throughout. Starting torque is 0.004 in-oz. Ratios up to 650:1 are available without increase in length; but ratios up to 20,000:1 can be produced in longer units. The gear head

is designed to operate synchro and potentiometer type loads. Bowmar Instrument Corp., 2602 Pennsylvania St., Fort Wayne, Ind.

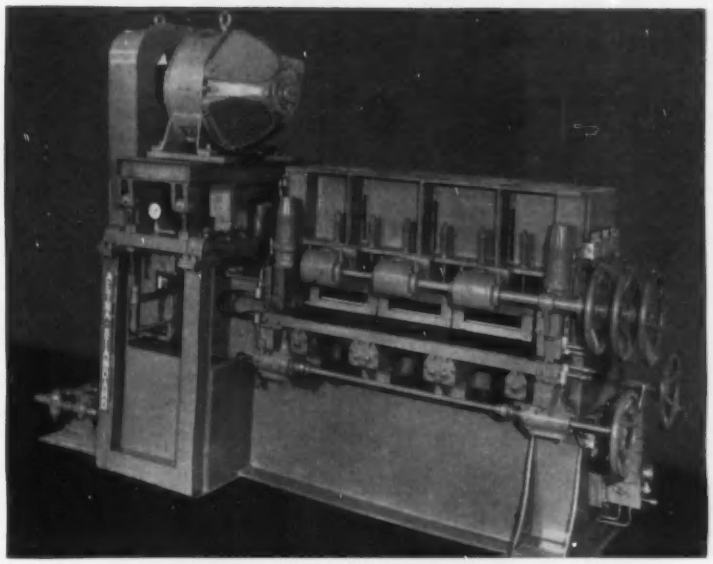
For more information—
Circle 27, inside back cover

Non-Adjustable Thermostat

Control can be provided with factory preset temperature settings from 80 to 300 F, positive snap-action operation. Over-center toggle mechanisms, magnets or complicated parts are replaced by a snap-action disk. Contacts and disk are enclosed for

CONTINUED ON PAGE 234

BEARING TIPS by McGill



138 GUIDEROL® BEARINGS BACK UP WORK ROLLS IN AETNA STANDARD LEVELER

High load capacity vital to back-up roll support

For processing 16 to 30 gauge steel sheets and coils, this Roller Leveler built by Aetna Standard Engineering Company requires dependable components to deliver a consistent maximum output at speeds up to 400 feet a minute.

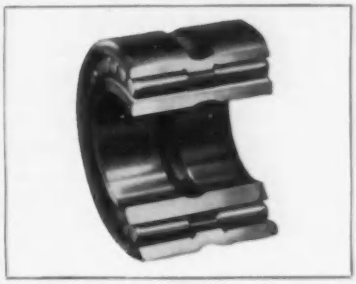
McGill GUIDEROL GR-16 bearings were selected for this machine and several larger versions use GR-24 and GR-36 bearings. They can carry the heavy irregular loads associated with flattening and leveling steel sheets and strips. Requiring less radial space, Guiderol bearings provide maximum roll neck diameters and offer greater strength at the necks of larger back-up rollers.

On the machine shown above, there is a total of 36 back-up rollers in 3 upper banks and 33 in 3 lower banks to resist the heavy pressure of the 48 inch working rolls. With a GUIDEROL bearing at each end of the 1¾" back-up rolls, a total of 138 bearings is required for the Leveler. These bearings have proved especially suited to supporting heavy loads longer in small radial space with reduced maintenance and production down time — important in steel mill operations.

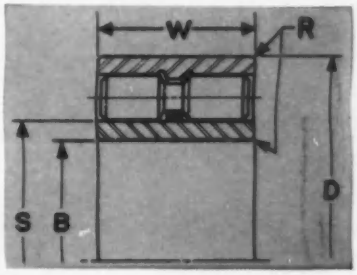
American Hoist Uses CT Series In Crane Blocks

Crane Blocks built by American Hoist and Derrick to withstand the greater strains and rough usage of lifts up to 500 tons rely on the greater capacity of GUIDEROL CT Series bearings in the sheaves. Interchangeable with retainer type cylindrical roller bearings, the CT Series full type roller construction has added capacity of over 38%. In sheaves these bearings offer greater angular stability with full race width rollers. Center guiding without retainer keeps these rollers aligned and prevents binding under eccentric loads.

Center-Guided Rollers Eliminate Load Wasting Cages



Guiderol Bearings inherently possess exceptionally high radial load capacity due to their full complement of small diameter rollers. Grooved rollers and a center guide rail keep rollers aligned as insurance against skewing and binding that is possible with ordinary needle bearings. Sizes interchange with needle and cylindrical roller bearings.



CT Series Adds Guided Roller Advantages to Cylindrical Roller and Ball Bearing Sizes

CT Series Guiderol Bearings provide the load carrying advantages of center guided rollers in cylindrical roller and ball bearing sizes. They are interchangeable in both single and double row dimensions. Inner rings are separable and may be eliminated to reduce radial space.

140 Pages of Bearing Facts

Write for your copy of Catalog No. 52, a revised 140-page Bearing Selection Guide. It contains vital product information and 30 pages of engineering data.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL
Full Type Roller Bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

protection against dirt, lint, dust. The disk can be exposed for faster thermal response where necessary. The unit can be mounted in any position. Terminals are solder type. Electrical ratings: 10 amp, resistive, 110 v ac, 6000 cycles; 5 amp, resistive, 240 v ac 50,000 cycles. Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

For more information—
Circle 28, inside back cover

Oil Tight Electrical Wiring Box

This sheet steel wiring box is suitable for use with flexible, liquidtight electrical wiring conduit. Size is 4 x 2 x 2 in. deep. Cover has a neoprene gasket, and captived cover screws thread into blind holes in the box. Two mounting feet are spot welded to the box. All seams are welded. Hoffman Engineering Corp., 1304 Tyler St., Anoka, Minn.

For more information—
Circle 29, inside back cover

Removable Thermostats

Designed to simplify installing and servicing temperature pickups for fire alarms and other temperature monitoring systems, the self-contained plug-in thermal unit fits into standard lamp sockets and can be inserted as easily as changing a lamp bulb. These cartridges are used with standard sockets and can be mounted in junction boxes for flush mounting such as ceilings or walls, or for surface mounting in a variety of ways to suit special needs.

They are available in all temperature ranges; plug-in construction permits change from one range to another without disturbing wiring. Industrial Automation Corp., 2415 W. Montrose Ave., Chicago, Ill.

For more information—
Circle 30, inside back cover

Miniature D-c Motors

Designed for use in airborne accessory equipment, these motors are high-power, permanent-magnet units, available in ratings of 1/300 to 1/75 hp. Motors are wound for voltages ranging from 6 to 28 v, and operate at 5000-22,000 rpm. All units in this frame size are two-pole, ball-bearing dc motors. Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y.

For more information—
Circle 31, inside back cover

Miniature Power Resistor

Silicone-sealed, ceramic shell resistor is designed for terminal board or printed circuit mounting. The ceramic shell offers uniform outer dimensions and is unaffected by abrasion and rough handling. It can be close mounted, remaining completely insulated, and has high dielectric strength.

Specifications are: low temperature co-efficient of ±0.00002 per deg C, 0.1 to 55,000 ohm, tolerance of 5 to 0.05 per cent. Reon Resistor Corp., 117 Stanley Ave., Yonkers, N. Y.

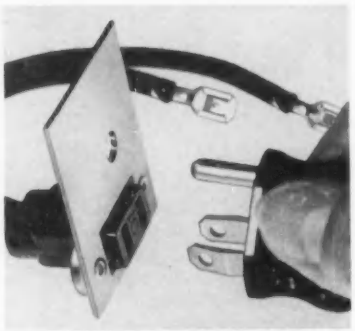
For more information—
Circle 32, inside back cover

Grid Paper For Designing Printed Circuits

A layout paper with reproducible grid is designed especially for the easier drafting of printed circuitry. Although the grid pattern is drawn to 1/10 in. spacing, drawings made on it may be two, three or four times actual size for clearer and cleaner reproduction after reduction to actual size.

This paper is 12x24 in. sheet size, and is available in lots of 100, 200 and 500 sheets at cost comparable to regular drafting paper stock. Photocircuits Corp., Glen Cove, N. Y.

For more information—
Circle 33, inside back cover



Remote Thermostat Socket And Extension Cable

Designed to overcome UL objections to the use of standard power outlets for remote thermostat connectors in the appliance field, this device provides a connector for power line take off to the thermostat units. A polarized plug extension cable is molded as an integral unit into a thermostat cable. This assembly is already in use on UL-approved coolers and is expected to find application in air conditioners, freezers and heaters.

The thermostat outlet is constructed with ¾ in. contact centers. Sockets are pre-wired with lead lengths tailored to the customer's requirements. Socket mounting plates are cadmium plated steel and provide for mounting on 1¼ in. centers by any of the conventional volume produc-

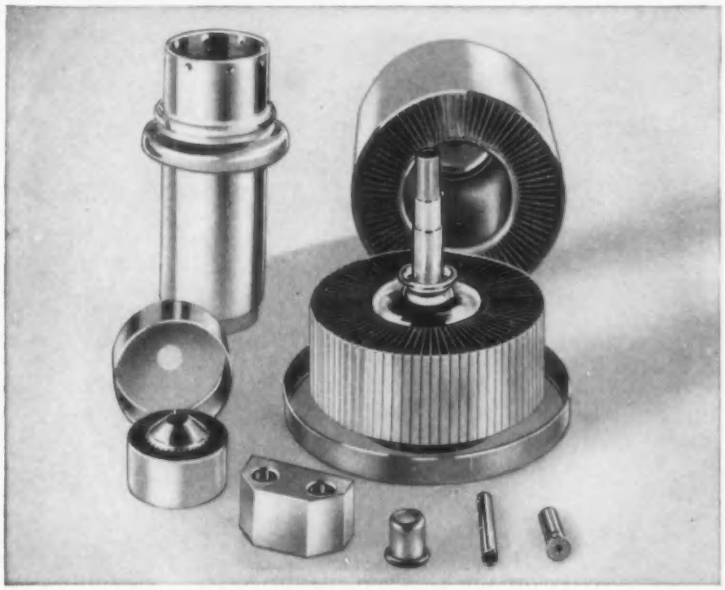
CONTINUED ON PAGE 236

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co.

Reporting new developments in copper-base alloys and metalworking methods.



Bridgeport Alloys Used for Heart of Transmitting Tubes

Today's rapid developments in radar and communications give increasing importance to the electron tube for generating and amplifying ultra-high and microwave frequencies for radar and communication systems.

In manufacturing electron tubes, Eitel-McCullough, Inc. of San Bruno, California—a leading producer of transmitting tubes—faced several difficult problems. The primary problem was that vacuum tube production requires firing at extremely high temperatures in a hydrogen atmosphere. Under these conditions, ordinary copper becomes spongy and porous. Specifying Bridgeport Oxygen-Free copper provides the solution.

Other major requirements for metals also exist. While the majority of electron tube components are formed, many are machined to exact dimensions from rod and tube. Eitel-McCullough requires a metal that can be easily fabricated in deep-drawing, is a good electrical conductor and is adaptable to plating. Here, too, Bridgeport alloys proved to be the solution.

Bridgeport alloys are used because they can meet Eitel-McCullough's exacting requirements in manufacturing and finished product performance, as well as providing consistently uniform composition. Bridgeport O.F.H.C. copper is used for many tube parts—anodes, support structures, coolers, cooler cores, drift tube sections, index sleeves and static sleeves.

Transmitting tubes are one of many products using Bridgeport Alloys for special applications. Your product, too, can use Bridgeport "job matched" alloy. Call your nearest Bridgeport sales office today.

The Importance of "Machineability"

Low-cost, large-volume production depends on the "machineability" of the metal used to do the job. In establishing the machineability ratings of alloys, Bridgeport Metallurgists consider these five factors the most important: speed of machining... tool life... finish... accuracy... and power required.

While copper and each of its alloys have individual characteristics, Bridgeport copper-base alloys have been grouped into three broad machineability classifications:

Free-Cutting Alloys

Machineability rating 100% to 70%. All alloys in this group are leaded, and produce short, brittle chips. For example, most jobs that call for free-cutting brass rod can be entrusted to Bridgeport Ledrite #6 Standard, machineability rating of 100%. Ledrite #6 is easy to cut, gives longer tool life... products are smooth, clean-surfaced.

Moderately Machineable Alloys

Machineability rating 70% to 30%. This group covers some leaded refractory alloys and some non-leaded brasses. Bridgeport Duronze III, a silicon aluminum bronze, is also included in this classification.

Difficult to Machine

This group includes non-leaded copper, phosphor bronze, silicon bronze, nickel silver and commercial bronze. All produce long, tough, stringy chips.

Finding the right metal or alloy, with the right machineability rating is no chore—if you call Bridgeport. Close cooperation with our Technical Service Division has worked wonders for many fabricators—increasing quality and uniformity, reducing waste, cost of labor and materials. Write or call your nearest Bridgeport Sales Office for high-quality alloys, and for free expert advice in your metal selections. (1155)

Bridgeport Brass Co.

BRIDGEPORT BRASS COMPANY ♦ BRIDGEPORT, CONNECTICUT

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich. Sales Offices in Principal Cities—Conveniently Located Warehouses

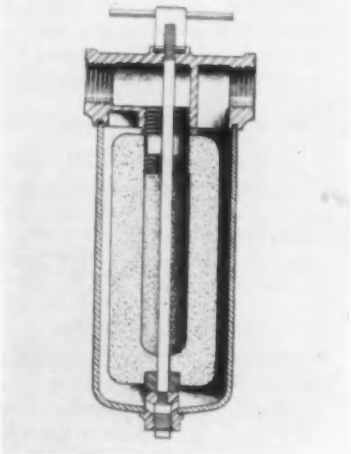
tion methods of eyelet, rivet, or spot weld. They are rated for current carrying loads up to 1,100 w. Dept. PD 456, Alden Products Co., Brockton, Mass.

For more information—
Circle 34, inside back cover

Sintered Iron-Bronze Bearings

Composed of approximately equal parts of iron and bronze, this metal powder alloy combines the economy and strength of iron with the antifriction and long-life properties of bronze. While primarily intended as a general-purpose, oil-retaining bearing material, it can also be fabricated into sintered structural parts. Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

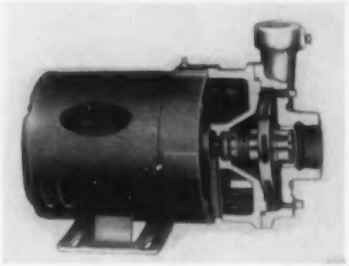
For more information—
Circle 35, inside back cover



In-Line Water Filter

The porous ceramic filtering unit is fastened inside an extruded aluminum shell, bolted to a cast aluminum top tapped for standard pipe threads. All aluminum parts are covered with a special plastic coating to resist corrosion. Filter is available in three sizes, ¾, 1, and 1¼ in. pipe openings. Ceramic units are available in fine, medium, or coarse pore sizes for each size. Filter surface area varies from 84 to 106 sq in., depending upon size. Filtros Inc., E. Rochester, N. Y.

For more information—
Circle 36, inside back cover



Motor-Mounted Centrifugal Pump

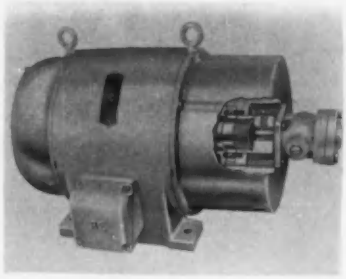
Designed specifically for air conditioning service, these units are also suitable for general circulating duty, industrial plant service, swimming pools and lawn sprinkling. Sizes range from ½ to 5 hp, with capacities to 140 gpm. All-bronze, enclosed type impellers are used. Shaft is stainless steel. Casing may be turned for horizontal or vertical discharge. Motors are ball-bearing, single or three-phase, 3450 rpm. Deming Co., Salem, Ohio.

For more information—
Circle 37, inside back cover

Flexible Gear Coupling

A spacer type flexible gear coupling makes it possible to remove the hubs from either shaft without disturbing the mountings of the connected units. The unit consists of flexible hubs on both the driver and driven shafts. The center unit, or spacer, has specially designed teeth at either end cut in such a manner that they mate with each sleeve in a spline fit and have no flexibility. The two sleeves connect the driver and driven units through the spacer. Couplings are made in standard stock models, sizes ⅜ to 3, with capacities of 4 to 80 hp at 100 rpm. Sier-Bath Gear and Pump Co., 9249 Hudson Blvd., N. Bergen, N. J.

For more information—
Circle 38, inside back cover



Spline-Coupled Hydraulic Pump Motor

These pump motors are available in ratings from 15 through 40 hp in frame sizes 324U and 326U. Supplied for either single or double-end pump installations. Reuland Electric Co., Alhambra, Calif.

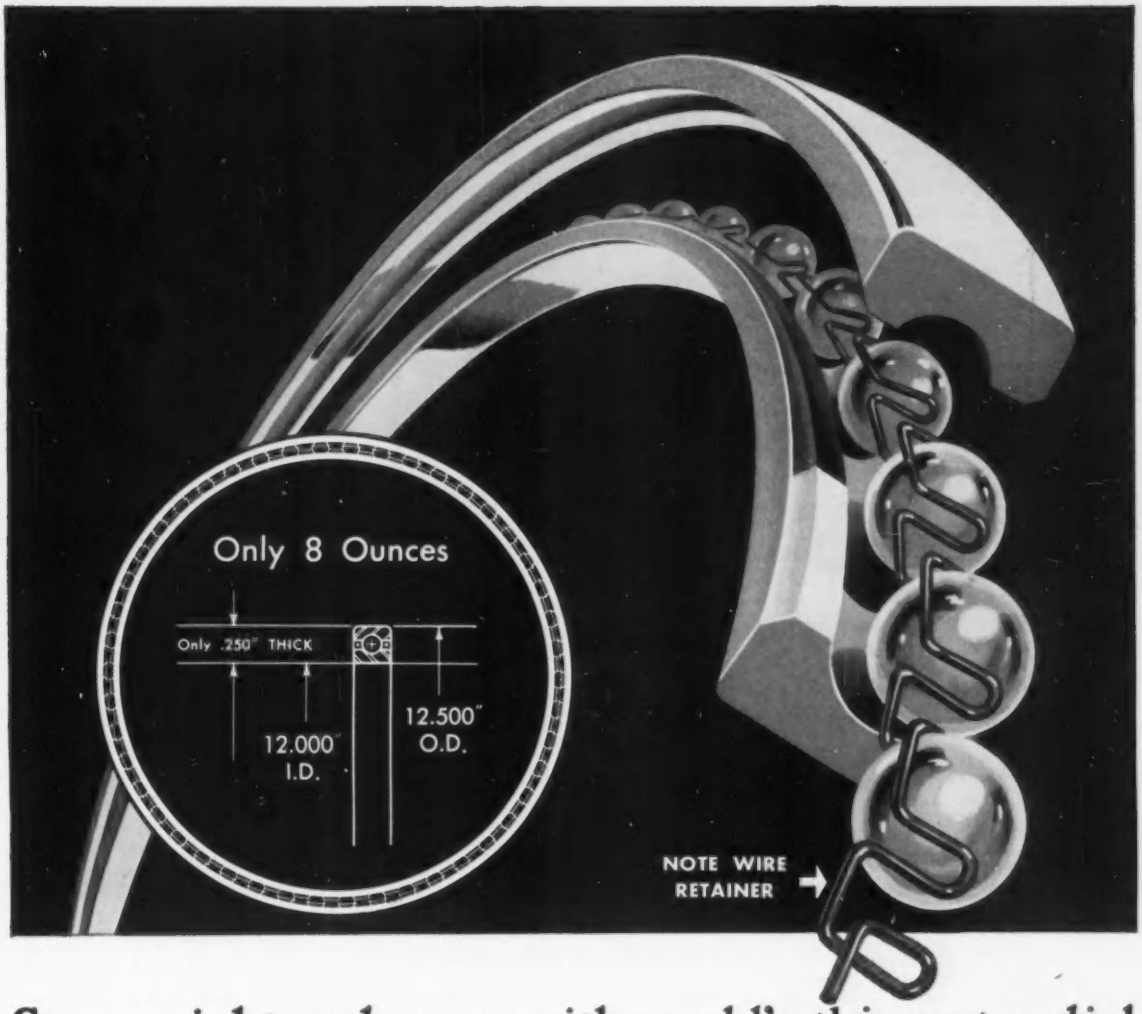
For more information—
Circle 39, inside back cover

Miniature Thermocouple Head

This is a miniature connection head (screw type) for thermocouples, electric heating elements or swaged, magnesium oxide, insulated conductors. Stem sizes adaptable to the head are 1/16, ⅛, 3/16, ¼ in. These sizes will provide a screw-type connection between the small thermocouple wires and the larger lead wires.

All sizes are made in two models,

CONTINUED ON PAGE 238



Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim,* high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

K-561

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings

plain and with angle bracket. Operating temperatures range up to 500 F. Marlin Mfg. Corp., 12410 Trisket Road, Cleveland 11, Ohio.

For more information—
Circle 40, inside back cover

External Wrenching Nut

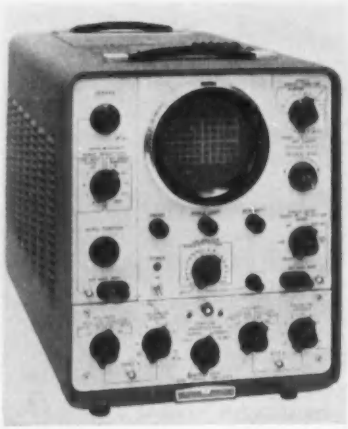
The 12-point, external wrenching nut is designed to permit the user to realize the full potential of the manufacturer's 220-240,000 psi tensile strength bolts. Increased thickness of the nut washer face plus the one-piece, all-metal design is said to provide sufficient strength to develop the full tensile strength of the bolt. The nut, 40 per cent stronger than those currently in use, is actually strong enough to break the bolt. The nuts are now being produced in diameters ranging from $\frac{1}{4}$ to $1\frac{1}{2}$ in. The nuts are cadmium plated. Standard Pressed Steel Co., Jenkintown 44, Pa.

For more information—
Circle 41, inside back cover

Oscilloscope for 100x

The dc to 500 kc horizontal amplifier provides sweep magnifications of 1, 5, 10, 50, and 100x, which together with the special horizontal position control offer a means of fine adjustment and examination of any 10 cm portion of the magnified range. The full sweep range is 0.02 microsec/cm to 15 sec/cm.

Triggering may be internal, external, or from the line voltage on positive or negative level and slope. The main vertical amplifier has a pass band from dc to 10 mc with optimum transient response and rise time less than 0.035 microsec. A fixed delay of 0.25 microsec permits viewing the leading edge of the signal triggering the sweep. Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.



For more information—
Circle 42, inside back cover

Valves Protected Against Load Drop

Multi-directional, sectional hydraulic control valves have positive protection against load drop without constriction of oil flow passages; for pressures up to 2000 psi. The valves have a built-in check in each working section which prevents any pressurized return flow from a cylinder supporting a load. Thus no load drop can occur even if two or more sections are in operating position at the same time. The checks give positive control in inching, and automatically hold any load while another is being positioned.

Since two sections may be operated simultaneously without danger of load drop, two operations can be carried on at the same time by throttling one section to match its pressure requirements to that of the other. To provide for smooth throttling beveled notches are cast into the housings so that as the spool is moved the paths for oil passage do not open abruptly.

The valves are available with $\frac{1}{2}$, $\frac{3}{4}$ and 1-in. work ports, having nominal capacities of 20, 35, and 60 gpm respectively. The three sizes of valves are each available in inlet, outlet, and four types of working sections. Working sections available are: single-acting, double-acting, double-acting with float in neutral, and double-acting with float in hold. Commercial Shearing & Stamping Co., Youngstown, Ohio.

For more information—
Circle 43, inside back cover

Vitreous-Enameled Resistors

This 3 w, axial-lead, vitreous-enameled resistor is available from stock in a range of resistance values from 1 to 10,000 ohm. The stock line now consists of three sizes rated at 3, 5, and 10 w. The 3-w size is $\frac{1}{4}$ in. dia x $\frac{9}{16}$ in. long. Ohmite Mfg. Co., 3677 Howard St., Skokie, Ill.

For more information—
Circle 44, inside back cover

Maximum-Minimum Thermometer

This instrument measures the ambient temperature and records both the lowest and the highest values over any given period of time. It has a replaceable paper chart on which a permanent record of the temperature

CONTINUED ON PAGE 240

Using

DU PONT ELASTOMERS

NEOPRENE • HYPALON®

in Design

HYPALON® can be compounded in an unlimited range of weather-resistant colors

HYPALON, Du Pont's new synthetic rubber, brings brilliant and varied colors as well as superior performance to the design field. Colored compounds of HYPALON start bright . . . *stay* bright despite severe exposure conditions indoors or outdoors. The samples shown above, for example, were subjected to two years of outdoor exposure. There is virtually no change in color and negligible change in physical properties.

In addition to outstanding color stability, HYPALON has many other advantages that can help your products give *extra-long service* on industry's toughest jobs. Compared to other kinds of rubber, HYPALON shows unusual resistance to hardening at elevated temperatures (250° to 350° F.). It is completely resistant to ozone and has exceptional resistance to strong oxidizing agents.

When your design calls for a resilient material that must have exceptional resistance to these conditions, it will pay you to take a close look at HYPALON.

NEOPRENE air-brake tube still in service after 5,500,000 flexings

No downtime in 4 years

The brake element shown is part of a clutch-and-brake unit which is capable of stopping heavy rotating equipment within 1/10 of a second. One such unit has piled up a record of 5,500,000 engagements in four years *without any maintenance*. The key to this kind of performance lies in the design of the machine and in the use of two rayon-reinforced neoprene tubes.

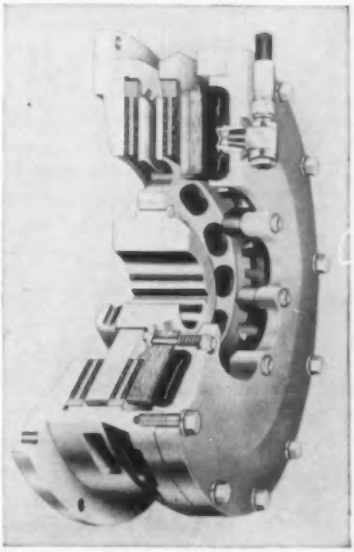
Typically, two of the pictured elements are used together, one serving as the clutch, the other as the brake. When the stop switch is thrown, compressed air is released from the neoprene tube in the clutch element; this disengages friction plates in the clutch and disconnects the drive motor from the driven machine. At the same time, in the brake element, compressed air is admitted to the neoprene tube, engaging friction plates and halting the machine.

Neoprene resists oil, high temperatures

Neoprene's superior oil resistance and durability at high temperatures have made the performance of this clutch and brake possible. Natural rubber tubes previously used were deteriorated by heat and by the oil that almost invariably gets into any compressed-air supply. They swelled, and the inside surfaces tended to become tacky and stick together. When rayon-reinforced neoprene air tubes were used, the problem was solved.

Neoprene makes a better design

In designing new products or improving old ones, neoprene stands up where ordinary resilient materials fail. Neoprene offers the designer resistance to oil, heat, weathering, chemicals and abrasion. It improves product performance—cuts maintenance costs. Complete property data and typical neoprene application data are available.



SECTIONAL VIEW of brake element, with Neoprene air tube in red

DU PONT
REG. U.S. PAT. OFF.

HYPALON *is a registered trademark of E.I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Please send further information and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON®," which show how the Du Pont elastomers are used in designing new products, improving old. I am particularly interested in

_____

_____

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, Dept. PE-6
Wilmington 98, Delaware

Name _____ **Position** _____

Firm _____

Address _____

City _____ **State** _____

ACP Service knows no hours

Our Technical Service Department works round the clock to set up a chemical treatment process for metals, and keep it working smoothly with minimum interruption in production.

Time is no factor when ACP technical service men move into your plant. They stick with the job until it's done. They not only furnish assistance in installing the system, but also instruct plant personnel in its operation. Then, to keep the process working effectively with a minimum of production slowdowns, they establish a schedule of periodic inspection, if you so desire. This permits ACP to check the operation of process and equipment, to analyze procedures, to suggest changes as needed to maintain uniform results.

This policy of service to its customers is not a new one with ACP—it has been going on for more than 40 years. And it doesn't stop with service in your plant. Our Engineering Department will design the equipment, our Pilot Plant will develop the process sequence, and our Quality Control Laboratories will maintain a continuing check on the processed metals. Write for complete information about ACP.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICHIGAN ST. JOSEPH, MISSOURI NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES

excursion is recorded. Two ranges are available, 50 to 250 F or −50 C to 100 C. Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.

For more information—
Circle 45, inside back cover

Hydraulic Motor Valve

These valves provide on-off control with tight shut-off of gas, oil, liquids and steam. They are suited for zone control in heating and air conditioning systems, and for hot and chilled water applications. They afford remote control in response to thermostats, limit or operating controls, remote switches or paralleling with motor driven burners, fans.

Normally open or normally closed and three-way types operate against a heavy return spring, incorporating a two-wire circuit that automatically returns to de-energized position in event of current failure. Operating pressures up to 300 psi are obtainable, in iron or bronze body. General Controls Co., Glendale, Calif.

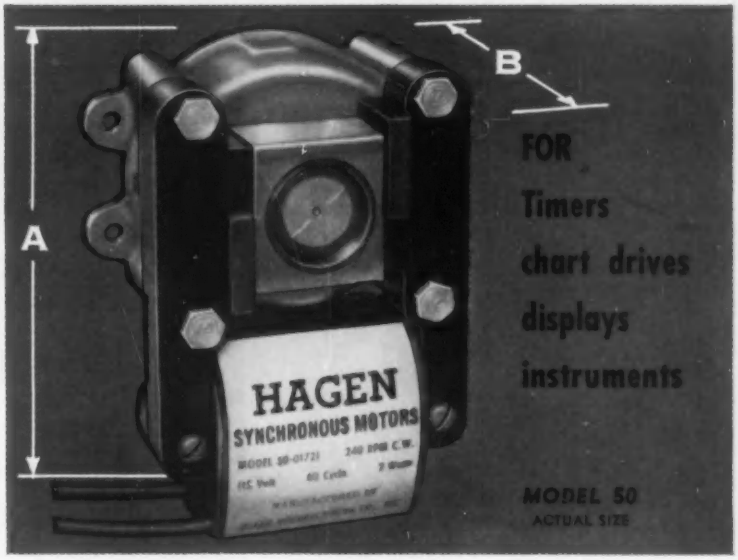
For more information—
Circle 46, inside back cover

Self-Hardening Plastic-Metal

A plastic metal compound has been developed which is reported to exceed all known steel and aluminum-filled epoxy resins in high impact strength and durability. The material is available in both liquid and non-sagging putty form. When mixed with the

(Continued on page 244)

HAGEN
Synchronous motors



most powerful for its size

Laminated rotor construction of the Model 50 Hagen Motor produces exceptionally high torque. For example, the rotor develops 10 ounce inches torque at 4 RPM. This motor is ideal for those applications requiring from 5 to 10 times the power of clock-type miniature motors. Yet in spite of its power, the motor is extremely compact:

DIMENSIONS

	50 to 60 cycle	25 cycle
A	3-3/32	3-1/16
B	1-13/32	1-23/32

Just a few of the many possibilities for use are: door chimes, laundry timers, depth finders, animated displays, heating controls, program clocks, fire alarm systems, integrators, time switches, chart drives, scoreboards, potentiometer drives. Motor may be mounted in any position. Wide selection of output speeds from 1800 to 1/6th RPM. Reversible and other models available. Send coupon for Bulletin No. 1055.

MAIL COUPON TODAY

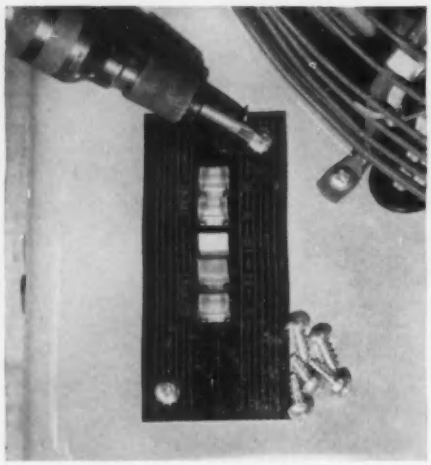
HAGEN MANUFACTURING COMPANY, INC.
Dept. PE-656, Moline, Illinois
Please send Bulletin 1055 on Hagen Synchronous Motors.

NAME AND TITLE
COMPANY
ADDRESS
CITY ZONE STATE

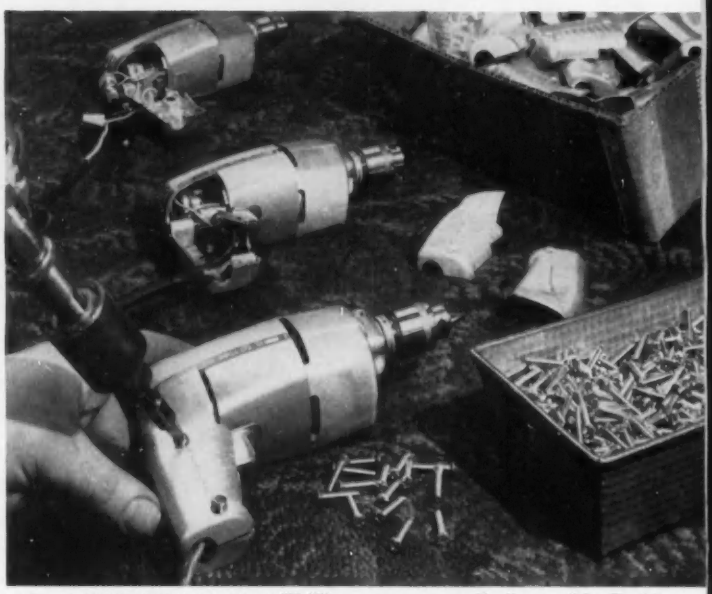
HAGEN
MANUFACTURING COMPANY, INC.
Moline, Illinois Barstow, Wis.
Subsidiary of Eagle Signal Corporation

Three Users Give Many Reasons For Using

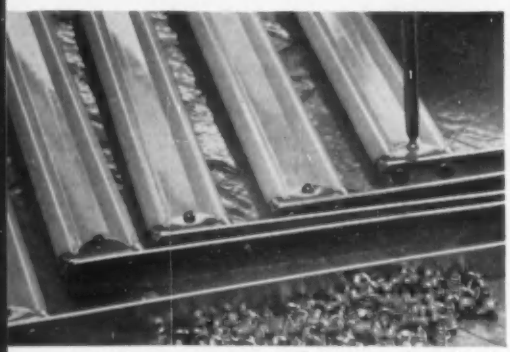
PHILLIPS CROSS RECESSED HEAD SCREWS



SAMSONITE LUGGAGE uses Phillips Cross-Recessed-Head Screws to hold the alabaster plastic garment bar to metal hanger. "Not only are recessed head screws required in all our specification sheets, but Phillips is the one type specified throughout," says Mr. W. G. Axtell, Chief Engineer of Shwayder Brothers.



"WE USE MORE THAN 1,000,000 Phillips screws annually," says Mr. R. M. Shoemaker, liaison engineer for Portable Electric Tools, Inc., "they reduce danger of damage to finished parts, affect a tighter bond, upgrade production and enhance the appearance of our end product."



"WE USE PHILLIPS 100%," states Mr. R. A. Burket, Production Manager of McGraw Electric Co., Lonergan Manufacturing Division, "because experience has taught us that they are the fastest assembled in high-speed production line, hold their bond indefinitely under conditions involving constant vibration, and make a more decorative finished product."

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY...
AND OF THE FUTURE
X marks the spot
the mark of extra quality

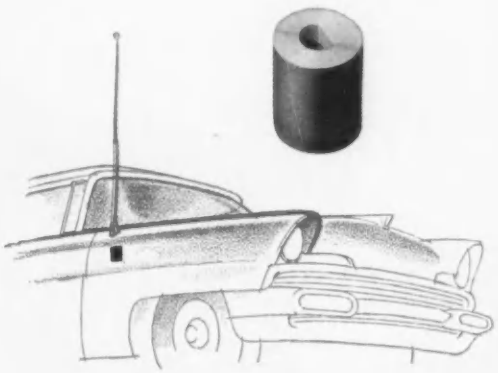
Pledged to highest standards...

The Phillips Screw manufacturers listed here cooperate to turn out a uniformly high standard of quality. As sponsors of the Phillips Cross-Recessed-Head Standards Committee they adhere to the established dimensional standards, gauges, and gauging methods which will best serve industry.

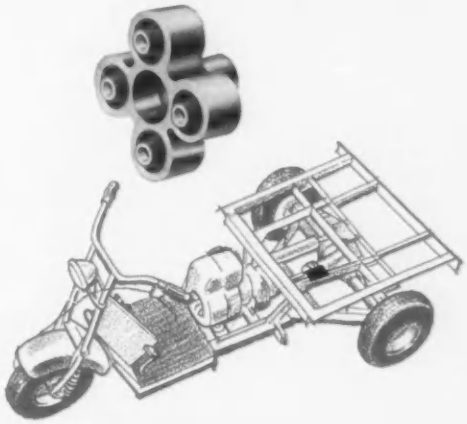
Members of Screw Research Association

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Co. Elco Tool and Screw Corporation • Great Lakes Screw Corp. • The H. M. Harper Company • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Company • Parker-Kalon Division, General American Transportation Corporation Pheoll Manufacturing Co. • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Universal Screw Company • Wales-Beech Corporation

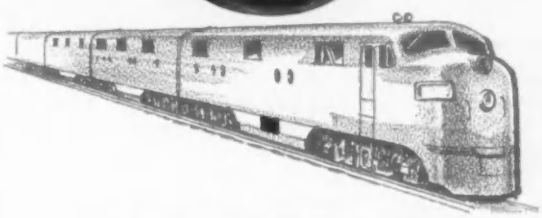
no lubrication, less vibration and noise with low-cost **LORD** flexible couplings



1/50 hp @ 5000 rpm—Flexible coupling to drive electrically actuated radio antenna on automobiles was Lord-designed to overcome noisy operation of all-metal unit. In addition to noise reduction, coupling accommodates 8° misalignment.



5 hp @ 3200 rpm—Low-cost Lord Flexible Coupling replaced costlier universal joint on three wheel industrial motor scooter. Used on drive shaft, it accommodates misalignment, eliminates lubrication.



300 hp @ 1200 rpm—Lord engineered this flexible coupling for a high-capacity application on locomotive auxiliary drive shaft. Unit provides desired vibration isolation and noise reduction, also accommodates slight shaft misalignment.

LORD engineers have special skills in designing Flexible Couplings for your specific requirements. Precision LORD bonded rubber units such as the examples shown here, effectively reduce noise and vibration on all types of installations from small automotive units to huge locomotives.

Bring your special flexible coupling problems to LORD. Specialized LORD engineering has solved many complex coupling problems and can probably solve yours with a low cost, high-efficiency bonded rubber coupling that will give outstanding performance. Simply call or write the LORD Field Office nearest you or the Home Office today.

LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA

NEW YORK, N. Y. - Circle 7-3326 • PHILADELPHIA, PA. - LOcust 4-0147
CLEVELAND, OHIO - SUperior 1-3242 • DAYTON, OHIO - Michigan 8871
DETROIT, MICH. - TRinity 4-2060 • CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - Riverside 3392 • LOS ANGELES, CAL. - HOllywood 4-7593
"In Canada—Railway & Power Engineering Corporation Limited"

LORD
BONDED RUBBER

designers and producers of bonded rubber products since 1924

AUTOMATION
the Nickeloid Way

Even before they arrive at your plant, Nickeloid PRE-Plated Metals are 60% through your production process. No cleaning, plating or polishing . . . that's been done for you—expertly, uniformly, accurately. You just fabricate; then assemble. By-pass 3 out of 5 basic production steps. Reduce costs up to 20%; save time and lower investment in inventory and equipment.

Specify Nickeloid PRE-Plated Metals, in durable uniform finishes of chrome, nickel, copper or brass on base metals of steel, zinc, copper, brass or aluminum.

SHEETS • COILS • STRIPS
A variety of finishes and patterns

SEND FOR FREE SAMPLER-SELECTOR
In handy slide-chart form, gives specifications, finishes and typical uses of Nickeloid Metals. 8 metal samples. Request yours on your company letterhead.

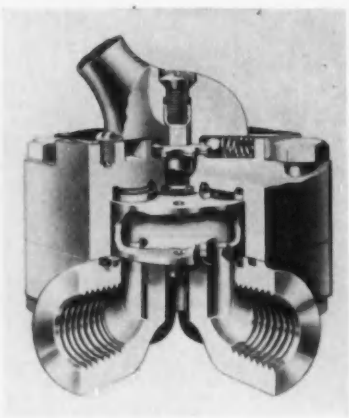
NICKELOID METALS
SINCE 1898

Sales offices in most principal cities

AMERICAN NICKELOID COMPANY
Peru 4, Illinois Mills: Peru, Ill. — Walnutport, Pa.

catalyst supplied, it hardens in minutes, and produces a fine grain surface, which sands and machines like soft grey iron. Takes primer, lacquer or baked enamels perfectly. Unaffected as low as −60 F, as high as 350 F. Travaco Laboratories, 233 Condor St., E. Boston 28, Mass.

For more information—
Circle 47, inside back cover



Selector Valve For 0 to 1000 Psi

These valves are recommended for air, gases, hydraulic oil, non-aromatic fuel, petroleum, and water services. Operating temperature range is −65 to 160 F. Working pressuse: air and gases, 0-500 psi; liquids, 0-1000 psi.

The valving disk is copper-coated steel, and has hardened stainless steel wearing surfaces. Body material is precision cast aluminum alloy, anodized. All bodies have side ports, tapped for 4-way closed center service. The unit is designed for panel mounting, $\frac{1}{8}$ in. max thickness. Sizes range from $\frac{1}{8}$ to 1 in., female pipe. Republic Mfg. Co., 15655 Brookpark Road, Cleveland 11, Ohio.

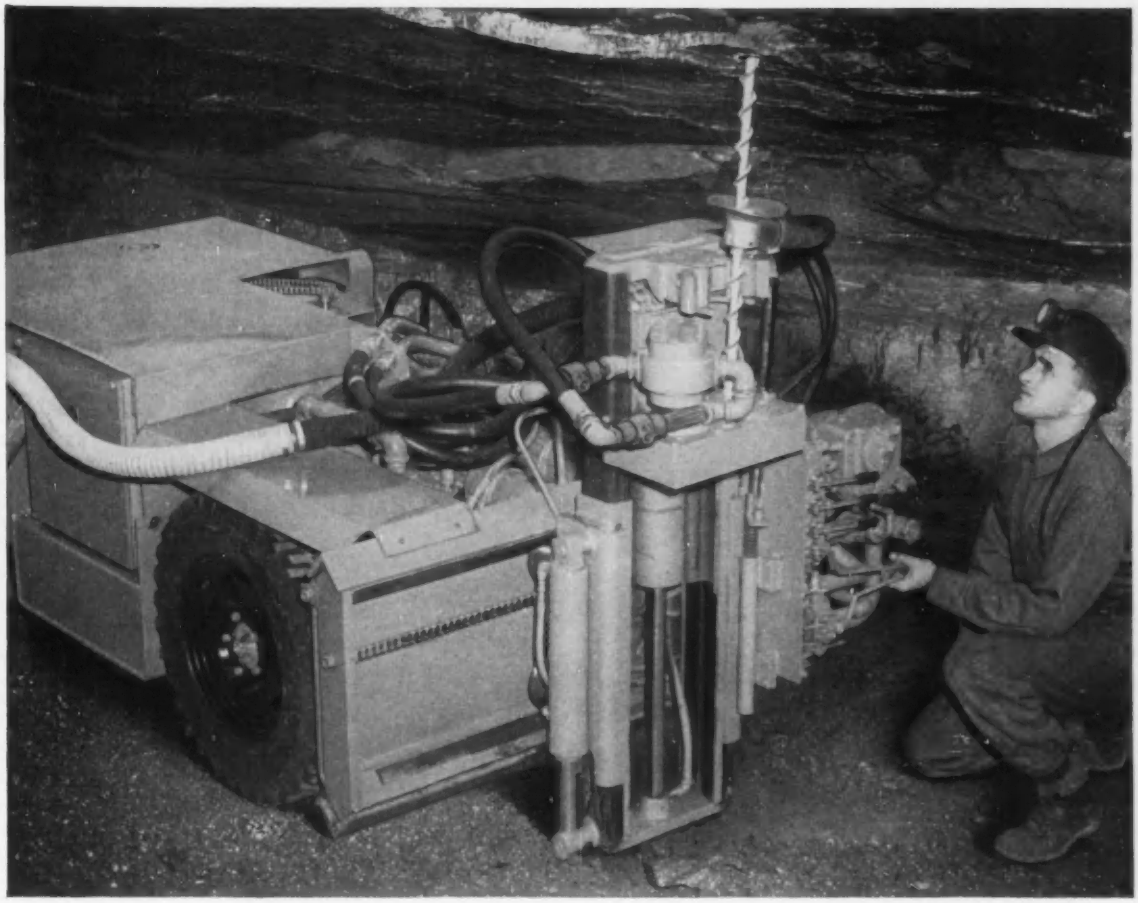
For more information—
Circle 48, inside back cover

Tubing for Electrical, Electronic Applications

A range of sizes of spaghetti tubing made from Teflon can be made in various colors for identification, has good dielectric strength (500 to 1000 v/mil); lowest dielectric constant

(Continued on page 246)

FLETCHER MINING EQUIPMENT REPORTS ON CHIKSAN SWIVEL JOINTS



LONG, SERVICE-FREE LIFE DESPITE EXTREME ABRASIVE DUST AND MECHANICAL ABUSE

When it comes to rugged service, the Fletcher Roof Drill really puts Chiksan Swivel Joints thru the paces. Installed on hydraulic lines where operating pressures run as high as 1800 psi, the Swivel Joints are used to minimize torque and eliminate knotting on lines as the bit is raised and turned. The Swivel Joints are subjected to extreme mechanical abuse and abrasive dust as the hard working drill bores a hole, then installs and tightens roof bolts in underground mines.

Yet with all of the extreme abuse and abrasive coating, the J. H. Fletcher Company reports Chiksan Swivel Joints continue to provide free swiveling action with exceptional maintenance-free service.

Assure yourself of this long-life, trouble-free service, by specifying versatile Chiksan Swivel Joints in your plant and equipment.

Chiksan Swivel Joints rotate 360° in 1, 2, and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

CHIKSAN

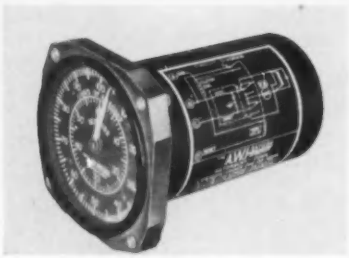
FOR FREE CATALOG WRITE DEPT. 17-6

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY, Brea, California • Newark 2, New Jersey • Well Equipment Mfg. Corp., (Division), Houston 1, Texas • Chiksan Export Co., Brea, Calif.; Newark 2, New Jersey • Chiksan of Canada, Ltd., Edmonton, Alta.

(2.0) and dissipation factor (0.0002) of any solid dielectric. There is no change of electrical properties with temperature (−100 C to 250 C) or frequency (60 cycles to 100 mc). In addition, the tubing is not affected by moisture. Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38 St., Philadelphia 4, Pa.

For more information—
Circle 49, inside back cover



Time-Governed D-c Motors

These motors are accurate to ±0.20 per cent of reading, ±0.20 ms, from −55 C to 85 C over wide voltage variations. They are available with an AN type mounting or a compact flange for applications where panel mounting space is limited.

Electrical reset of these stop clocks permits local or remote control or automatic operation for measuring successive time intervals. They can be used for calibration of intervalometers, fire control equipment, production testing, material fabrication, automatic spectrographic analyzers, laboratory analysis equipment, test rigs, flight simulators and training equipment.

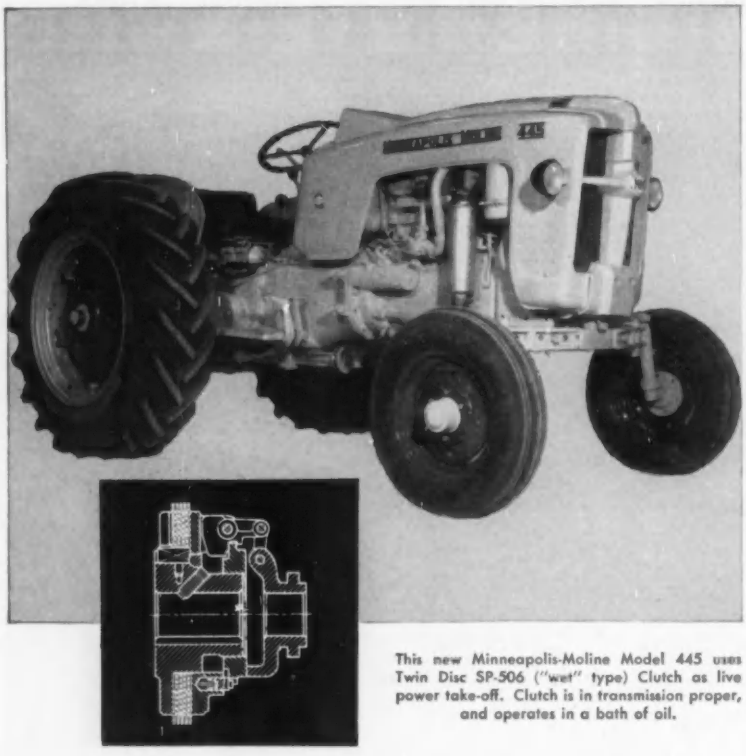
The operating voltage range of the motor and clutch coil is 20 to 30 v, dc. Reset time at any temperature is 2 sec, max, an operating altitude is from sea level to 50,000 ft. A. W. Haydon Co., Waterbury, Conn.

For more information—
Circle 50, inside back cover

Footswitch Housed In Aluminum

The switch is made of cast aluminum with a ribbed surface; size is 3½ x 2¾ x 1⅝ in. high. This model is available in a 10 amp, 125v ac, single-

(Continued on page 251)



This new Minneapolis-Moline Model 445 uses Twin Disc SP-506 ("wet" type) Clutch as live power take-off. Clutch is in transmission proper, and operates in a bath of oil.

Twin Disc provides specific answers to clutch and power take-off problems on tractors

For more than *30 years*, Twin Disc Engineers have worked closely with designers and manufacturers of farm machinery — to provide *specific answers* to their clutch and power take-off problems.

A typical example of this long, successful relationship is the *custom designed* SP-506 ("wet" type—multiple plate) Clutch used as a live power take-off on the new Minneapolis-Moline Model 445.

In addition to farm tractors, such as this, and the Oliver Super 55 — Twin Disc products appear in a number of diversified forms — from clutches in the newest Case Field Forage Harvester to torque converter components in the newest and largest crawler tractors, manufactured by Allis-Chalmers, Caterpillar and International Harvester.

Twin Disc is prepared to *custom design* clutches for *your specific needs* —using many standard components to create *minimum tooling charges* and *low unit prices*. If you have a clutch or power take-off problem, write or call Twin Disc Clutch Company, Racine, Wis.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois
Branches or Sales Engineering Offices: Cleveland • Dallas • Detroit • Los Angeles • Newark • New Orleans • Tulsa

for young men who want to catch up to their bosses . . .

Alcoa's Up-to-Dater on Forgings

Four factual pages of news on the world's largest aluminum die forging, latest alloys, titanium, brass forging costs, hand forgings and other information for young men who want to catch up to their bosses.

Here's the world's largest

Forging history is being made as you read this. At Alcoa's Cleveland plant the world's largest closed die aluminum forging is being made. The part is a structural member for a jet bomber aircraft wing. It is 13 feet long, 3 feet wide, 12 inches thick. And it weighs 3,715 pounds. The die blocks weigh 60,000 pounds each. It is being forged on the giant 50,000-ton press operated by Alcoa for the United States Air Force.

Another example of what these giant presses save in machine time, man-hours and money is a jet bomber bulkhead. Alcoa was first asked to make it as an aluminum hand forging. We did, and it weighed 1,625 pounds. Redesigned, it was next made as a blocker-type forging on Alcoa's 15,000-ton press. It weighed 830 pounds. Now, here's the kicker. Redesigned again, the part was placed on the 50,000-ton press and squeezed out as a precision forging. This time it weighed 290 pounds! And imagine what happened to costs!

What does this illustrate? Simply that larger, more intricate forgings are a practical reality the way Alcoa makes them on the large hydraulic presses. Die life is lengthened. Draft angles drop from the customary 7° to 0°, in some cases. Machine time is cut dramatically. Thinner webs and ribs are possible. The actual forging, because it is squeezed instead of pounded,has smoother surfaces, less chance of surface defects, slivers and laps. And while you may never design a part that requires the facilities of our 15,000-, 35,000- or 50,000-ton presses, it's obvious that experience learned in solving problems like these can effect savings on your parts, regardless of the size and quantity. Let us prove it.

Need just a few? Need them in a hurry? Try hand forgings

Hand forgings come awfully close to what the blacksmitn can beat out with an anvil and hammer. Except in Alcoa's shops,they grow to 2,500 pounds

Alcoa's Up-to-Dater on Forgings (continued)

and 300 inches long and 40 inches wide. Alert designers specify hand forgings when part requirements are few, or when designs are not final. In so doing, they avoid die costs and lost time.

This is old stuff to some, but we wonder if all designers realize that hand forgings can be had in far more intricate forms than the usual bars, slabs, biscuits, etc. And, further, they can be had in all the forging alloys.

The closer a hand forging approaches the shape of the finished part, the more metal and machining time is saved at your plant. Also, better mechanical properties come when the stock is forged to lighter sections. This extra quality is reflected in the strength of the finished part. But the dollars add up as a forging gets closer to the finished part. When does it pay? It depends on such things as machining costs, scrap wasted, work-load in your plant, properties necessary, etc. How to find out? Give your Alcoa sales engineer a sketch or drawing of the finished piece and an idea of the number needed. He will suggest the hand forging that might best serve your needs. Or, if you prefer, he will submit several propositions involving hand forgings ranging from the simplest shape to others coming closer and closer to your finished part.

We have just printed an informative, technical booklet, *Alcoa Hand Forgings*. Make sure you ask your Alcoa sales engineer for a copy. Or drop us a line.

Big news on small stuff

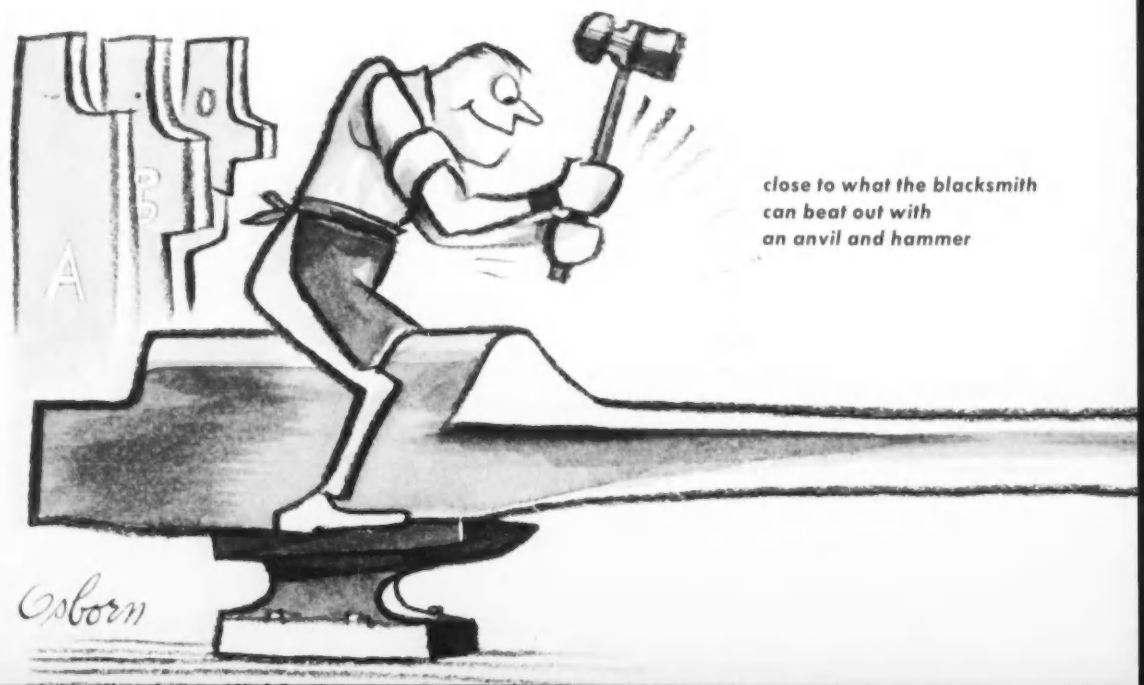
We often get so wrapped up in 50,000-ton presses and 2,500-pound hand forgings that we fail to mention a substantial part of your business and ours, i.e., small forgings. We operate a large percentage of our vast number of hammers and mechanical presses continuously on small forgings. These jobs are in our shops instead of somebody else's for one of several simple reasons: They cost less, and/or they're made better, and/or we deliver 'em faster, and/or we give more engineering service. It's the plain, unanodized truth that we can do the same for you. Let us quote.

The latest on titanium forgings

Titanium being the fourth most abundant structural metal in the earth's crust gives us more than a passing interest in the stuff. We don't make the basic metal sponge, or alloy it in ingots. But we are doing considerable development work in its fabrication that could easily accrue to your benefit. Titanium forgings are a case in point.

Being the country's largest light metal forging facility, we have equipment to do some remarkable things with titanium. Heavy-press capacity lets us forge it at optimum temperatures. This reduces the oxide film that forms at high temperatures and also results in better properties. Our pioneering work in no-draft forgings of aluminum plus superior die design work has helped us eliminate many problems of titanium forgings. These and other techniques, which we are keeping under wraps, permit us to offer titanium forgings at some mighty competitive prices.

Capacity now in operation can handle titanium forgings in sizes up to 30x60 inches. Deliveries run about the same as aluminum. Typical properties go something like this: 150,000 tensile, 140,000 yield, 15 per cent elongation.



close to what the blacksmith can beat out with an anvil and hammer

do some remarkable things with titanium

We see a lot in titanium beyond aircraft and ordnance. High-temperature processing equipment for corrosive materials is already a proven market for titanium forgings. Likewise severe marine applications. Now is the time to do some hard commercial planning with titanium. We'd like to help.

Buying brass forgings? Why?

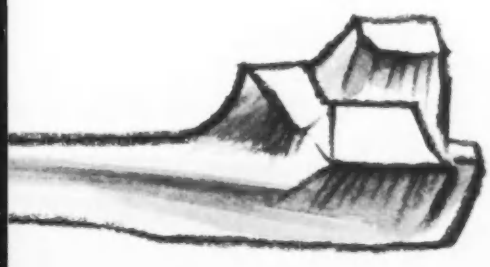
"Why"—since aluminum costs one-sixth as much as brass?

"Why"—since aluminum has become so easy to forge?

We don't expect these simple facts to undermine the foundations of the brass forging industry. But they are particularly pertinent in these competitive days. We don't mean to imply that every part now forged in brass would be less costly in aluminum. But the plain truth is that if more users of brass forgings would ask themselves "Why," there'd be a whopping lot of money saved.

A tour through Alcoa's forge plants will show aluminum forgings such as valve and pipe fittings, luggage hardware and many other parts that used to be brass. They are now aluminum for one main reason only. Cost. Yet it is equally true that these users have gained more than money. Their products are lighter—about half as heavy for equal strength. They are rustproof. They can be colored any shade of the spectrum right in the metal surface. They conduct heat and electricity like—well, like brass.

If you have an inkling that your brass part might cost less in aluminum, let us inkle with you. The difference could be considerable, and the consultation is painless and free.

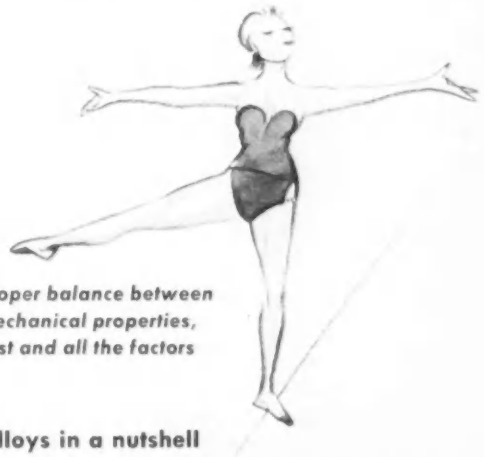


About quality control

This is something that everyone talks about, and few have to a degree that makes it really worth while. Usually the palaver goes something like this: "Every step is closely guarded by standards of rigid quality control, using utmost skill and the latest methods of inspection."

Next time you hear something like that, get the specifics and check them against Alcoa's tally: Ultrasonic inspection, fluorescent penetrant inspection, destructive testing, sectional testing for grain flow, Brinell tests, plus hundreds of visual checks and inspections throughout the process.

There's a difference.



proper balance between mechanical properties, cost and all the factors

Alloys in a nutshell

Maybe the toughest nut in designing for aluminum forgings is picking the right alloy. On the next page is a skeleton table along with brief comments about each alloy. Note alloys X-7079 and X-2219, just announced a few months ago. Alloy X-7079 is a new high-strength deal like 7075. But it provides a higher level of short transverse elongation plus being less apt to distort on machining. Alloy X-2219 offers a lot of new features for problems in 500-600°F range. There's lots more to the alloy story and we think your Alcoa salesman is the right man to help you get the proper balance between mechanical properties, costs, and all the factors that go into the picking of the alloy that's exactly right for your job.

Alcoa's Up-to-Dater on Forgings (continued)

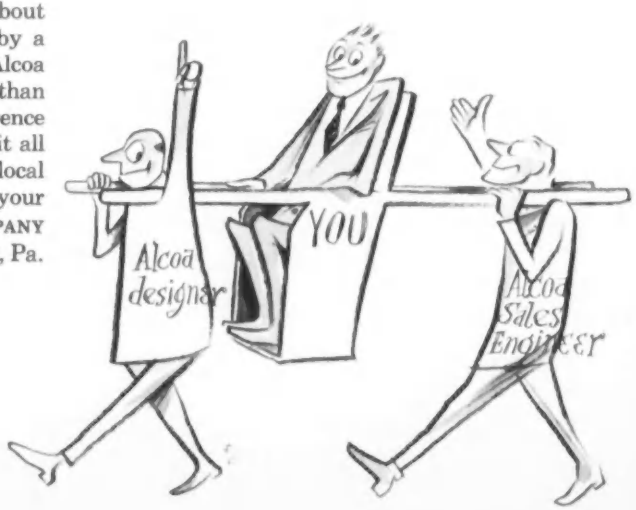
MECHANICAL PROPERTIES OF ALCOA® ALUMINUM FORGINGS

	MINIMUM SPECIFICATION VALUE (1)			TYPICAL VALUES (1)			
ALLOY	TENSILE STRENGTH	YIELD STRENGTH	ELONGATION % in 2"	TENSILE STRENGTH	YIELD STRENGTH	ELONGATION % in 2"	BRIEF ADVANTAGES OF ALLOY
2014-T6	65,000	55,000	10	70,000	60,000	13	readily forgeable, high strength.
X-2219	55,000	35,000	6	62,000	43,000	16	high strength in 500-600°F temperature range.
6151-T6	44,000	37,000	14	48,000	43,000	17	good mechanical properties, readily forgeable.
7075-T6	75,000	65,000	10	82,000	72,000	11	highest strength.
X-7079	74,000	64,000	10	78,000	68,000	14	high strength, improved ductility in transverse, less quench sensitive.
4032-T6	52,000	42,000	5	55,000	46,000	9	high strength at elevated temperature. Selection between these three alloys depends on individual requirements.
2218-T72	38,000	29,000	8	46,000	36,000	10	
2018-T61	55,000	40,000	10	62,000	48,000	12	
6061-T6	38,000	35,000	10	45,000	40,000	17	superior welding and brazing qualities, readily forgeable, corrosion resistant.
2025-T6	55,000	33,000	16	58,000	37,000	19	special-purpose propellers, etc.

(1) For forged sections to 4" thick for all alloys except 7075-T6 which is 3" and X-7079 which is 6".

Straight talk

In these days of designing for sales as well as performance, many a designer has found a competitive edge in Alcoa Forgings. This often comes about through solid technical thinking contributed by a local Alcoa sales engineer and a designer in Alcoa forge shops. It is this help, perhaps more than machines and equipment, that makes the difference in dealing with Alcoa. And the practicality of it all is that it's free. Your first step is to call the local Alcoa sales office listed under "Aluminum" in your classified phone book. Or write, ALUMINUM COMPANY OF AMERICA, 1994-F Alcoa Bldg., Pittsburgh 19, Pa.



Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM FORGINGS

Litho in U.S.A.

pole, double-throw or double-pole, double-throw; also 15 amp, 125 v ac, single-pole, double-throw. Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.

For more information—
Circle 51, inside back cover

Gear Motor For High Shock

An internally geared air compressor motor is being produced for aircraft duty in a rigid, one-piece pyramidal base. The motor operates continually on three-phase, 400 cps, 208 v ac, and has a take-off speed of 3700 rpm. At sea level the motor delivers 3.5 hp, with the rating varying to 2.5 hp at 50,000 ft. Weight of the motor is 22 lb. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 52, inside back cover

Absolute Pressure Transmitter

A pressure transmitter will measure pressures in ranges as low as 0 to 5 mm mercury absolute and transmit the measurement as a 3-15 psi pneu-

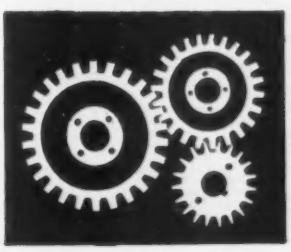
(Continued on page 254)

From huge aircraft engines to tiny precision instruments—there's no end to the variety of products improved by Perkins custom-cut Gears!

Perkins is a *gear engineering* organization with a 35 years' tradition of New England craftsmanship as background. As one of the country's largest producers of gears to customers specifications, Perkins will meet your specific requirements for gears—regardless of size, type, material or quantity desired, *and at competitive prices*. You furnish the specifications, we'll produce the gears.

PERKINS MAKES in all materials, metallic or non-metallic, and in any size, to your specifications: helical gears, bevel gears, sprockets, ratchets, worm gears, spur gears with shaved or ground teeth, ground thread worms.

NOTE: The **PERKINS PRECISION SPRING COILER** is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want *when* you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire Sizes .005 to .125. Diameter from 3/32" to 12" and larger. Size of the compact coiler is only 7½ x 16". **A POWER MODEL** mounted on a welded steel console cabinet base is also available. Full information on request.



Perkins Machine & Gear Company
105 Circuit Avenue
West Springfield, Mass.

A combination...for relaxation at Home

Laminated plastics... a combination of properties at work

It takes a combination of properties to satisfy many of your basic material requirements. Synthane laminated plastics provide a unique combination of mechanical, electrical and chemical properties plus ease of machining.

High-speed reversing clutch cone made of Synthane molded-macerated laminated plastic increases productivity of automatic screw machines. Synthane meets all the demands of high-speed clutch operation . . . *light weight, great strength* and *excellent heat resistance* for split-second reversing of a positive spindle drive operating as high as 3025 rpm and with operating temperature of cone going up to 250°F. This Synthane clutch cone provides smooth, positive clutch action, is long wearing, and is not distorted or deteriorated by the high heat.

Property combinations! Synthane has them... in over 30 individual grades... sheets, rods, tubes, moldings and completely fabricated parts. Send for free illustrated catalog today.

COMPRESSIVE STRENGTH

HEAT RESISTANCE

LIGHT WEIGHT

WEAR RESISTANCE

SYNTHANE

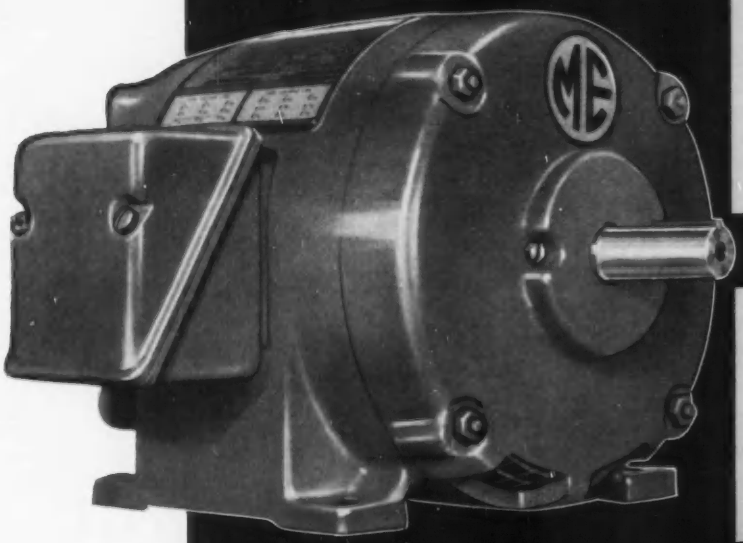
SYNTHANE CORPORATION, RIVER ROAD, OAKS, PA.

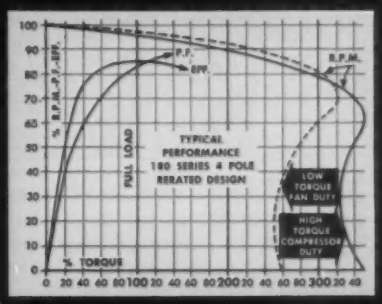
WHY MARATHON ?

• **EXPERIENCE OF PROVEN PERFORMANCE . . . OVER HALF A CENTURY**
There is no substitute for the reliability of proven ME performance. Top names of the Nation's Industry have proven ME performance in ENGINEERING . . . DESIGNING . . . PRODUCING QUALITY PRODUCTS.

• **VERSATILITY WITH A WIDE RANGE OF DESIGN**
MOTORS 1/20 thru 2500 HP . . . GENERATORS ½ thru 2000 KW . . . Single Phase, Polyphase, Direct Current . . . Standard or Special . . . Marathon Electric can design to meet your special specifications.

• **SERVICE THROUGHOUT THE NATION**
MARATHON ELECTRIC has a DISTRICT OFFICE or Representative near you. Call your ME Representative TODAY to help solve your motor problem.





MARATHON RERATED NEMA FRAMES provide 4 in 1 PROTECTION

DRIP PROOF **WEATHER PROTECTED**
SPLASHPROOF **GUARDED**

MARATHON ELECTRIC'S new rerated NEMA frame design packs all these requirements into a single unit . . Available in standard ratings for high torque-compressor duty or low torque-fan duty, or made to your specifications.

SINCE 1913

MARATHON ME ELECTRIC

HOME OFFICE AND FACTORY, WAUSAU, WIS. FACTORIES AT ERIE, PA. AND EARLVILLE, ILL.

SALES OFFICES IN PRINCIPAL CITIES

Write or Wire SPADE 11 for further Information

New "gun" sprays hi-temperature ceramic coatings at high speed with high deposit efficiency

The unique characteristics of ceramic coatings as heat insulators and their resistance to abrasion has led many designers to investigate possible applications for these materials. However, their actual use has been severely limited because of the high cost of application with previously available spraying equipment.

Now with the new METCO THERMOSPRAY GUN these materials can be applied many times faster than was previously possible and deposit efficiency is in excess of 95%, making the use of these coatings economically feasible.

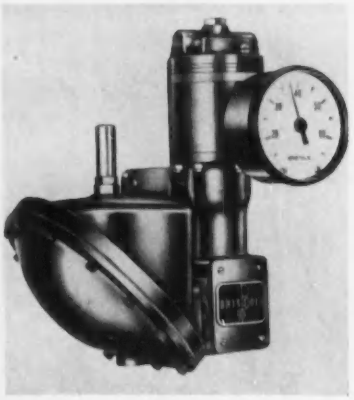
These high spraying speeds and deposit efficiencies are made possible by entirely new design concepts which result in the excellent thermal efficiency of the METCO Type P THERMOSPRAY GUN as well as the specially developed and carefully controlled characteristics of the THERMOSPRAY Ceramic Powders.

The following trade names are the property of Metallizing Engineering Co., Inc. METCO, THERMOSPRAY. *Reg. U. S. Pat. Off.*

for additional information see facing page

METCO®

Metallizing Engineering Co., Inc.
1173 Prospect Ave., Westbury, L. I., New York · cable: METCO
In Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England



matic signal to an automatic controller or receiver.

The device is offered to handle pressure ranges from 0-5 mm Hg to 0-760 mm Hg. It transmits a universal 3-15 psi pneumatic signal, and can be used with any standard pneumatic receiver or automatic controller. Bristol Co., Waterbury 20, Conn.

For more information—
Circle 53, inside back cover

A-c Motor-Tachometer

This 400-cps miniature motor-tachometer was designed for air-borne precision integrating and rate servos. Linearity error is 0.05 percent over a 0 to 4000 rpm range, 0.05 per cent scale error over an ambient temperature range of −55c to 75c, and the 400 cps null voltage is reduced to virtually zero (less than 1 millivolt in phase and quadrature). Output voltage at 3600 rpm is 3.6 v within 0.5 per cent and is in phase with the excitation voltage within 0.05 deg.

The servo motor is a four-pole

(Continued on page 255)

motor whose no-load speed is 9500 rpm and has a stalled torque of 0.9 in-oz with 7 w per phase input. The motor-tachometer unit is flange mounted and is 1.437 x 4¼ in. long. Precision Components, Inc., 65 Rushmore St., Westbury, N. Y.

For more information—
Circle 54, inside back cover

Valve For Air-Operated Clutches

This dual air valve is specifically designed to actuate the clutch and brake of mechanical power presses. It is said to eliminate one of the hazards of press operation, accidental stroking due to valve failure. The valve consists of two valve elements working independently in parallel, and cross-ported with extra large exhaust outlets. Should either element fail, the clutch will be exhausted and disengaged normally through the second valve element. Danly Machine Specialties, Inc., 2100 S. Laramie Ave., Chicago 50, Ill.

For more information—
Circle 55, inside back cover

Vibration Calibrater

This is an instrument designed to calibrate vibration pick-ups or to measure vibration of non-magnetic, metallic surfaces. Vibratory displacements are compared with a precise standard displacement. Furthermore, the probe requires no direct contact with the vibrating surface. The calibrator measures vibration amplitude over four decade scale ranges, from 20 microinch to 0.02 in. full scale. On all ranges readings are independent of frequency from 10 to 20,000 cps. Accuracy is

(Continued on page 256)

Hi-temperature sprayed ceramic coatings now economically practical

Open new possibilities for the design engineer

Development of the new METCO THERMOSPRAY GUN for spraying high-melting-point ceramic materials at low cost opens up a variety of new practical applications for the design engineer, particularly in the protection of equipment against high temperatures and abrasion.

Immediately available for use in such production applications are two THERMOSPRAY Ceramic Powders. No. 101 is a free-flowing alumina with excellent hardness and resistance to many types of abrasion. Melting point is 3700°F. and particle hardness is 9.0 on the Moh scale. Color of this material as sprayed is a light grey. Second THERMOSPRAY Powder is No. 201—a zirconia, somewhat softer than No. 101 but with superior heat-insulating properties. Melting point 4600°F. and particle hardness 8.0 on the Moh scale. Color—tan-brown.

Both of these materials may be sprayed with the new THERMOSPRAY equipment many times faster (up to 15 sq. ft. per hr.—.010" thick) than has been possible for equipment previously available and deposit efficiencies are in excess of 95%. These factors produce extremely low coating costs and make coatings of this type economically feasible.

Preliminary engineering data contained in Bulletin 127 is now available and may be obtained by filling out the coupon below or writing on your company's letterhead. There is no obligation involved.

Spraying thermocouple tube with zirconia to provide superior protection against high temperatures.

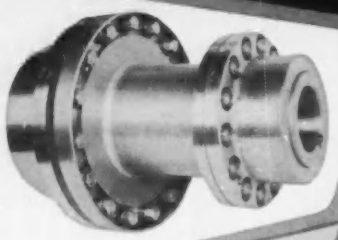
Hard-facing alloys, *of the self-fluxing, nickel-boron-silicon type, in powder form, can also be applied with the METCO Type P* THERMOSPRAY GUN. *Write for Bulletin 126.*

FREE BULLETINS

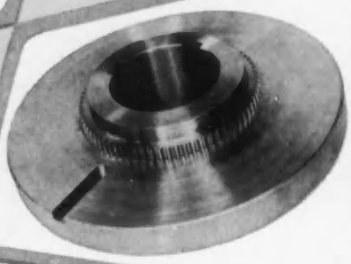
METCO
Metallizing Engineering Co., Inc.
Westbury, L. I., N. Y. • Great Britain: Chobham near Woking

1173 Prospect Avenue, Westbury, Long Island, New York
Please send me ☐ free bulletin 127 (Ceramic coatings), ☐ free bulletin 126 (Hard facing).
NAME
TITLE
COMPANY
ADDRESS
CITY ZONE STATE

Does your problem call for a Specially Built Coupling?



Specially designed Coupling for use in a wind tunnel



WALDRON Coupling hub with special plate provides required sliding motion

then put your problem up to

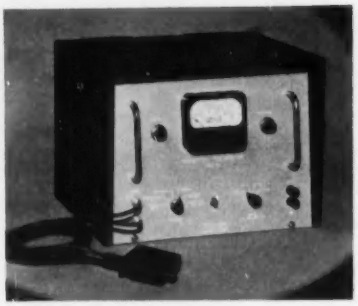
Waldron

The extensive engineering and manufacturing facilities maintained for the production of our popular standard type couplings put WALDRON in the most favorable position for handling special orders. WALDRON is the recognized source for prompt service on unusual coupling applications.

JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.

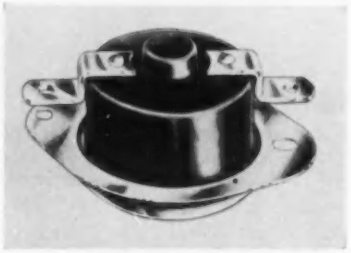
Sales representative in Principal Cities

STANDARD TYPES — Waldron COUPLINGS — SPECIAL TYPES



said to be better than 5 per cent of full scale in the measurement of sinusoidal or nonsinusoidal waveforms. Dept. 205, ACF Electronics, 800 N. Pitt St., Alexandria, Va.

For more information—
Circle 56, inside back cover



Appliance Thermostat

Suggested applications are electric clothes dryers, washers, dryers, ranges, control and high-limit switches for electric heating equipment. The unit's snap-action disc can be enclosed to provide complete protection against dirt, lint, dust, or exposed for faster thermal response where necessary. Fixed setting temperature settings range from −10 F to 350 F. The unit can be mounted in any position, in casting wells, through openings in metal enclosures and in space for control of air temperature. Electrical ratings up to 45 amp, resistive, 240 v, ac have been submitted for UL approval. Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

For more information—
Circle 57, inside back cover

Venting Traps

Designed to automatically discharge accumulated air or gas at the high points of a liquid or closed system, these traps are furnished in semi-steel

(Continued on page 260)

Chances are at least **98 out of 100** that this part will be **perfect**

The Metal Stampings Plant, Sylvania Electric Products, Inc., keeps rejects under 2%—even on complex, close-tolerance parts produced at rates to 9,000 per hour. Optical gaging helps set this level.

The diode plate shown above is an example of the complex, mass-produced, parts turned out to close tolerances by The Metal Stampings Plant, Sylvania Electric Products, Inc., at York, Pennsylvania. Tolerances run to ± .001″; as many as 10 dimensions must be held, including inner and outer diameters. Yet even on parts more difficult than this—parts with tolerances of .0005″ and forming rates of 9,000 per hour—Sylvania gets an acceptance rate of over 98%.

Inspection on Kodak Contour Projectors helps Sylvania do the job to the satisfaction of its customers, both internal and external. Operators check the first parts produced by every machine to assure correct setup. Then, throughout the run, production samples are checked at regular intervals—making certain each machine is holding to tolerance. The speed with which these parts can be checked using optical gaging methods has helped slash rejection rates more than 50% since Kodak Contour Projectors were installed.

If you have difficult inspection problems involving quantity, speed, close tolerances or hard-to-measure dimensions like shoulders, holes, radii or angles, there's every reason to expect a solution by optical gaging on a Kodak Contour Projector. There's a representative in your area who can tell you more. To get in touch with him, or for a copy of the booklet, "Projection Gaging with Kodak Contour Projectors," write Special Products Sales Division.

Little training is required to operate a Kodak Contour Projector. Operators sit comfortably in a fully lighted room. The work gets out in a hurry.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
TRADE-MARK

Simple Arithmetic...

Type 302, Sheet Base Price 44.50 cents per lb.

Type 430, Sheet Base Price -34.50 cents per lb.

Saving 10.00 cents per lb.

in Stainless SHEET Costs!

Now You Can SAVE $200 Per Ton!

Many designers and fabricators who are currently using Type 302 stainless can, in numerous applications, specify Type 430 straight chromium stainless and take advantage of the 10 cents per pound difference in base price. Some of our customers are already saving more than $200 per ton using our 430 MicroRold stainless sheet.

The steel industry estimates that 50% of all stainless sheet applications could satisfactorily employ Type 430, the least expensive of all stainless grades, as an economical and practical material. When properly applied, Type 430 has all the desirable qualities of beauty, corrosion resistance, strength, long life and low maintenance that no other material, except stainless, can offer.

We are currently producing our MicroRold Type 430 sheets in thicknesses .005″ to .109″ with 2B or 2D finishes; and in thicknesses .010″ to .109″ in No. 3, 4 and 7 finishes.

Send for Your copy, "Care and Use of 430 MicroRold Stainless Steel"

Washington Steel *Corporation*

6-G WOODLAND AVENUE, WASHINGTON, PA.

Designers' Guide for Selection of Hose Lines

● EXCELLENT

● GOOD

□ CONDITIONAL

○ UNSATISFACTORY

TYPE OF FLUID / AEROQUIP HOSE NUMBER	1501	1501D1	1502 (Buna N)	1502 (Neop.)	1503 (Buna N)	1503 (Neop.)	1508	1509 (Buna N)	1509 (Neop.)	1509A (Neop.)	1513	1524	1525	1531	1532	1533 (Buna N)	1533 (Neop.)	1534	1538	1540	1541	1546	1547	2556	2850	2851	2750
Acetic Acid (conc.)	□	□	□	□	□	□	□	□	□	□	●	□	□	●	□	□	□	□	□	□	●	□	□	□	□	●
Acetic Acid (dil.)	□	●	●	□	●	□	□	●	□	□	●	●	●	□	●	●	□	●	●	□	●	●	●	●	●	●
Acetone	○	□	○	○	○	○	○	○	○	○	○	●	○	○	●	○	○	○	○	□	○	●	○	○	○	○	●
Acetylene	□	●	□	□	□	□	□	□	□	□	□		□	□	●	□	□	□	●	□	●	□	□	□	□	□	
Air	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Air, Hot	□	□	□	□	□	□	□	□	□	□	□		□	□	●	□	□	□	□	□	●	□	□	□	□	□	
Alcohols, Aliphatic	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Ammonia, Anhydrous	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Ammonia, Aqueous	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Ammonia Gas	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Asphalt	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Benzene (Benzol)	○	□	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	□	○	○	○	○	○	○	○	○	
Butane	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	●	●	●	●	●	●		
Carbolic Acid (Phenol), Hot	○	□	□	○	□	○	○	□	○	○	□	●	□	○	□	□	○	□	□	○	□	□	□	□	□	□	●
Carbon Dioxide (dry)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Chlorinated Solvents	○	□	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	□	○	○	○	○	○	○	○	○	○
Chlorine (dry)	□	□	□	□	□	□	□	□	□	□	○	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	○
Chlorine (wet or solutions)	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○		
Creosote Oil	□	□	□	□	□	□	□	□	□	□		□	□	○	□	□	□	□	□	○	□	□	□	□	□		
Diesel Fuel	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Ethers	□	●	●	□	●	□	□	●	□	□	●	○	□	□	□	□	□	□	●	□	□	●	□	□	□	□	○
Freon 12, 13	□	●	●	□	●	□	□	●	□	□	●	●	□	□	●	□	□	●	□	□	□	●	□	□	□	□	●
Fuel Oil	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Furfural	□	□	□	□	□	□	□	□	□	□	○	□	□	○	□	□	□	□	□	○	□	□	□	□	□	○	○
Gasoline, Refined	●	●	●	●	●	●	●	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●	●	●	○	○
Gasoline, Sour	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Hydraulic Oil	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Hydrogen	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Hydrolube	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Kerosene	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Ketones	○	□	○	○	○	○	○	○	○	○		○	○	●	○	○	○	□	○	●	○	○	○	○	○		
Lacquers and Solvents	○	□	○	○	○	○	○	○	○	○	○	○	○	□	○	○	○	□	○	□	○	○	○	○	○	○	○
Lindol, Cellulube	○	○	○	○	○	○	○	○	○	○		○	○	●	○	○	○	○	○	●	○	○	○	○	○		
Lube Oil (hot)	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Mercury	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Mineral Oil	●	●	●	●	●	●	●	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●	●	●	○	○
Naphtha	●	●	●	●	●	●	●	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●	●	●	○	○
Naphthalene	□	□	□	□	□	□	□	□	□	□	●	○	□	□	●	□	□	□	□	□	●	□	□	□	□	○	○
Natural Gas	●	●	●	●	●	●	●	●	●	●		●	●	○	●	●	●	●	●	○	●	●	●	●	●		
Oxygen	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Propane	●	●	●	●	●	●	●	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●	●	●	○	○
Pydraul F-9	○	○	○	○	○	○	○	○	○	○	●	○	○	●	○	○	○	○	○	●	○	○	○	○	○	○	●
Steam	○	○	○	○	○	○	○	○	○	○	○	●	○	□	○	○	○	○	○	□	○	○	○	○	○	○	○
Trichlorethylene	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	□	○	○	○	○	○	○	○	○	○
Toluene (Toluol)	○	□	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	□	○	○	○	○	○	○	○	○	○
Water, Fresh and Salt (cold)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Water, Fresh and Salt (hot)	○	●	●	○	●	○	○	●	○	○	●	●	○	●	●	○	●	●	●	○	●	●	●	●	●	●	●

This hose selector chart plus other engineering data is included in Aeroquip Catalog No. 200. Write for your copy today.

Engineering assistance available to manufacturers.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

get this KEY to lower assembly costs

There are new opportunities for cutting assembly costs in the "Key Locking" feature of KELOX Inserts and Studs. You can improve your product and reduce assembly costs with KELOX because these fasteners—

1. Provide a positive lock between insert or stud and parent body.
2. Provide higher stress allowable per space required.
3. Are simple to install and remove.
4. Make maximum use of tapped hole.
5. Afford considerable reduction in assembly weights.
6. Save space and improve product design.
7. Can be serviced in field without special tools.
8. Require no special threads.

KELOX Fasteners are part of a family of universally used PHILLIPS PRODUCTS that are designed, developed and distributed by a world-wide organization.

This highly specialized, technical group will be glad to assist you with your fastener problems. Use coupon below to get more facts on KELOX!

KELOX

Fasteners, Inc.

580 Fifth Avenue
New York, New York

SALES REPRESENTATIVES—

Universal Fasteners Co.
Centerville Road, P. O. Box 449
Sturgis, Michigan

F. D. Barringer Company
542 Spring Street, N.W.
Atlanta 3, Georgia

Monogram Manufacturing Co.
8557 Higuera Street
Culver City, California

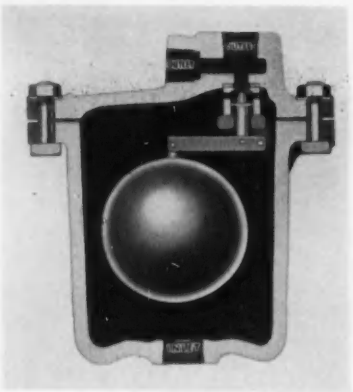
D. R. & W. Technical Service Company
P. O. Box 4
East Hartford, Connecticut

Scott Fittings Limited
339 Bering Ave., P. O. Box 169
Toronto 18, Canada

3395

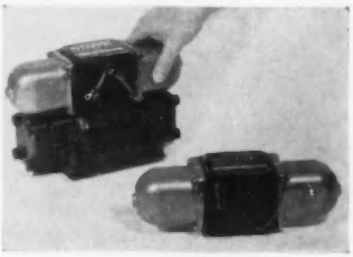
Please send me technical data on KELOX Inserts and Studs

Name ..... **Title** .....
Company .....
Address .....
Product being assembled .....



for high temperatures (to 450 F), to 250 psi and low temperatures to 300 psi; in fabricated steel for high temperatures (to 750 F), to 600 psi and for low temperatures 1,000 psi. Traps are furnished with a stainless steel ball float or with a non-collapsible stainless steel open-end float. Clark Mfg. Co., 1830 E. 38 St., Cleveland 14, Ohio.

For more information—
Circle 58, inside back cover



Solenoid-Controlled Directional Valves

A line of solenoid-operated and solenoid-controlled, pilot-operated directional valves are available for industrial oil hydraulic systems. The DG-5 valves are available as four-way units for ¾ and 1¼ in. normal and piping sizes. They can be obtained as single-solenoid, spring-offset models or with a double-solenoid, no-spring or spring-centered design. Spool types may be open, closed, tandem center, or other combinations and modifications. Solenoid-operated units in the new series are the DG-4 models. These valves are available as two-way or four-way units in ⅜ in. nominal size for ¼ in. piping size, also in ½ in. nominal size for ⅜ in. piping size. Spools are

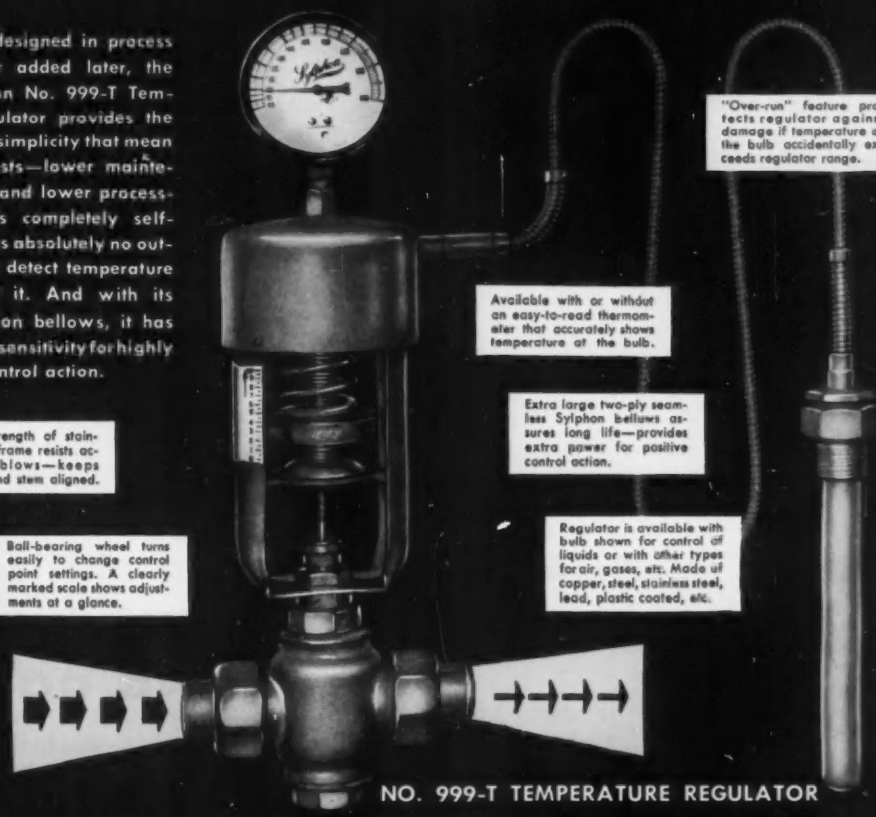
(Continued on page 264)

FULTON SYLPHON TEMPERATURE REGULATOR HEADQUARTERS, U.S.A.

CONTROLS TEMPERATURE
UNDER ITS OWN POWER

COMPLETE LINE OF REGULATORS, VALVES, MIXERS, AND CONTROLS FOR LIQUIDS, AIR OR GASES.

Whether it's designed in process equipment or added later, the Fulton Sylphon No. 999-T Temperature Regulator provides the accuracy and simplicity that mean lower first costs—lower maintenance costs—and lower processing costs. It's completely self-contained, uses absolutely no outside power to detect temperature or to control it. And with its famous Sylphon bellows, it has the power and sensitivity for highly responsive control action.



"Over-run" feature protects regulator against damage if temperature at the bulb accidentally exceeds regulator range.

Available with or without an easy-to-read thermometer that accurately shows temperature at the bulb.

Extra large two-ply seamless Sylphon bellows assures long life—provides extra power for positive control action.

Added strength of stainless steel frame resists accidental blows—keeps bellows and stem aligned.

Ball-bearing wheel turns easily to change control point settings. A clearly marked scale shows adjustments at a glance.

Regulator is available with bulb shown for control of liquids or with other types for air, gases, etc. Made of copper, steel, stainless steel, lead, plastic coated, etc.

NO. 999-T TEMPERATURE REGULATOR

Available with 60° F ranges between 20° and 455° F.
Variety of valve types in sizes from ⅛" to 4".

Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

Robertshaw-Fulton Controls Co.
FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

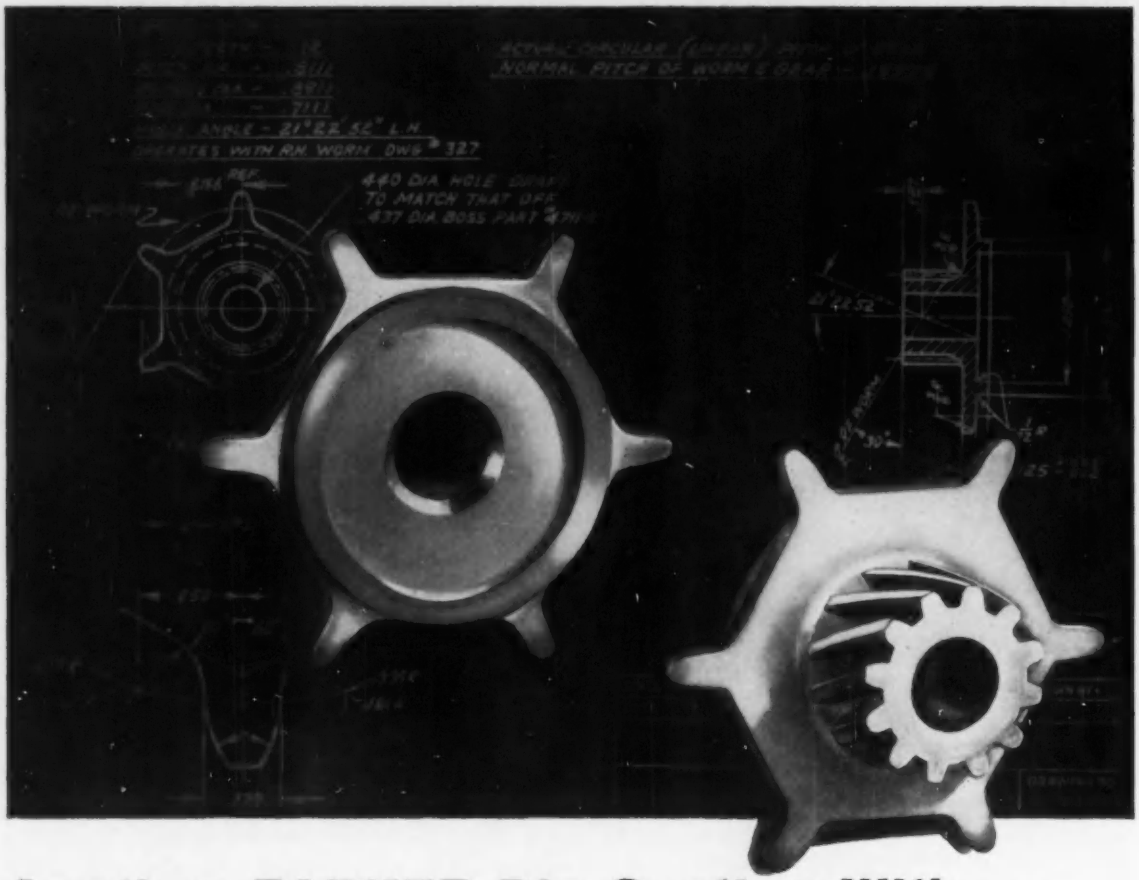
☐ Send literature on Temperature Regulators for Industrial Processes, Catalog D-LP

Name _____

Company _____

Address _____

City _____ State _____



Another PARKER Die Casting With... MACHINED PRECISION at DIE-CASTING COST!

Produced complete in one operation . . . to extremely close tolerances . . . this helical gear part is yet another example of the way Parker-engineered die castings can save you money by eliminating costly tooling-up and machining operations on component parts. Combine this inherent cost advantage with exceptionally smooth as-cast finish, high density and good tensiles and you can see why Parker Die Castings—in zinc or aluminum—open up wide new possibilities to the design engineer.

Parker has been a leader in die-casting for 50 years—an old hand with new ideas. Take advantage of this skill. Just call the nearest Parker sales engineer or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI, Ohio
William H. Broxterman • 2174 Buck Street

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

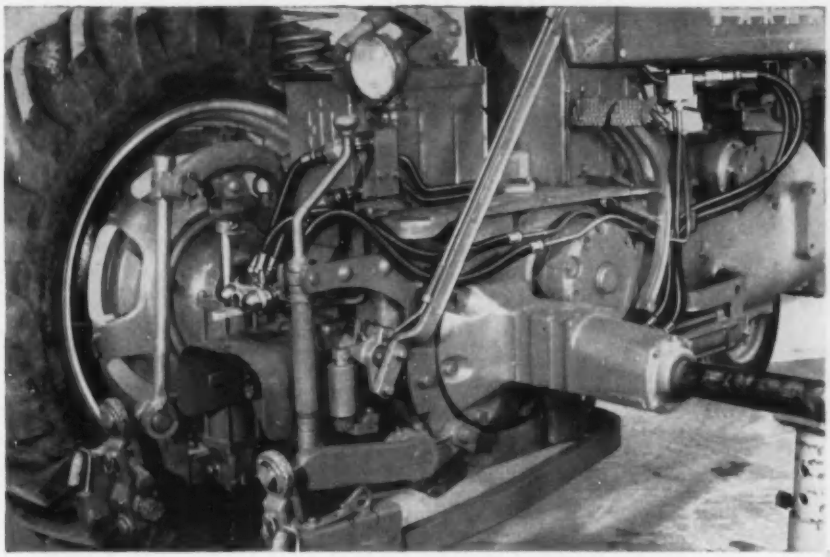
WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

PARKER

high pressure ALUMINUM and ZINC die castings
POWDERED METAL PARTS



INTERNATIONAL HARVESTER'S
McCORMICK FARMALL 400
Tractor controls every implement action hydraulically through its famous Hydra-Touch hydraulic system. Individual, closely grouped levers permit independent or unison control of cylinders.

HYDRAULIC POWER . . . DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES . . .

Most competitive Farm Implement Sales Feature

HYDRAULIC POWER probably contributed more to the usefulness, efficiency, and easy operation of farm tractors than any other modern engineering development. Farmers appreciate hydraulic advantages so much that they have become one of the *most competitive features in implement and tractor sales promotion.*

EASTMAN MANUFACTURING COMPANY is proud to have among its many agricultural users the International Harvester Company—dating back to the first McCormick Reaper—in 1831. Eastman—*first in the field* of Hydraulic Hose Assemblies—lists many other agricultural implement manufacturers among its users: J. I. Case, Allis-Chalmers, Massey-Harris-Ferguson, Inc., Minneapolis-Moline, Farmhand, Avco, and others.

IMPROVE THE COMPETITIVE POSITION OF YOUR PRODUCTS with Hydraulic Power—delivered through Eastman Hydraulic Hose Assemblies. Always specify Eastman: First in exclusive engineering advantages and design! First in materials and workmanship! *First in the field* of Hydraulic Hose Assemblies!

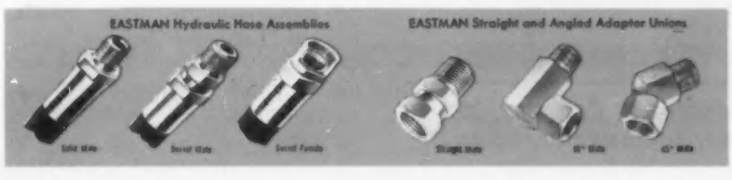
WRITE **Send your specifications and blueprints for our original equipment quotations.**

HYDRAULIC POWER controls plow penetration and depth automatically, lifting and locking in traveling position.

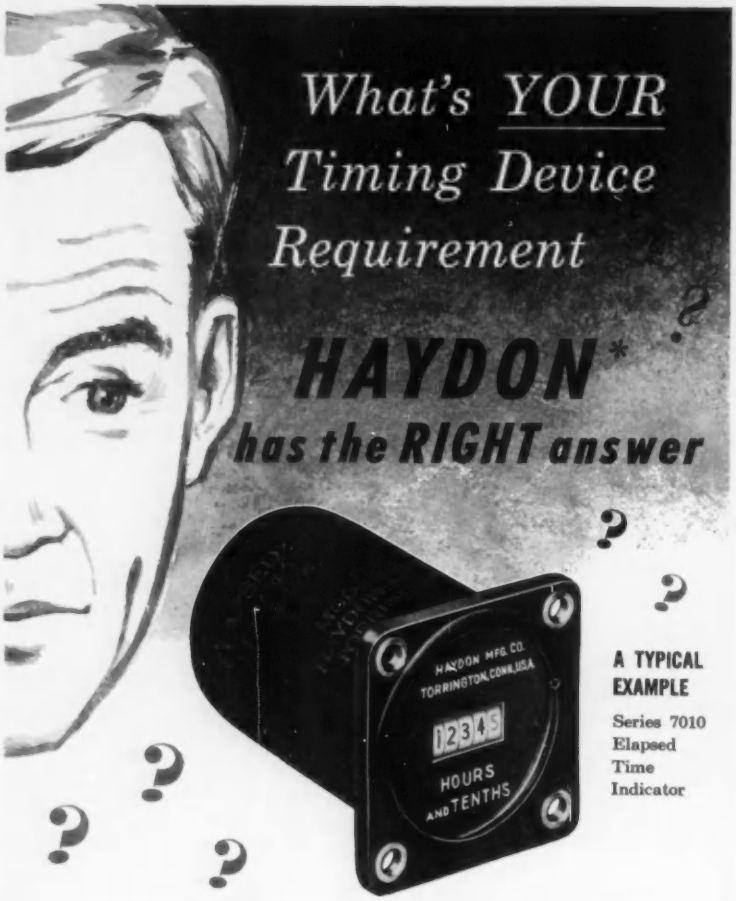
HYDRAULIC POWER controls angle and depth of disc penetration on International Fast-Hitch Bush and Bog Harrow.

HYDRAULIC POWER enables Farmall 200 Hydra-Creeper to travel 1/5 to 1 mile per hour for transplanting.

HYDRAULIC POWER permits raising right, left, or rear cultivator gangs separately, together, or any combination.



Eastman
first in the field
MANUFACTURING COMPANY
Dept. PE-6, Manitowoc, Wis.



A TYPICAL EXAMPLE
Series 7010 Elapsed Time Indicator

THE RIGHT MOTOR . . . *unusually compact, fully enclosed mechanism, controlled lubrication, simple, accurate and dependable, operates in any position.*

THE RIGHT DESIGN . . . *for any application because you can select from the full line of HAYDON STANDARD interval timers, time delay relays, cycle timers, and elapsed time indicators.*

THE RIGHT FACILITIES . . . *because HAYDON has the fully integrated engineering and manufacturing facilities to produce and deliver quality on time . . . economically . . . in large or small lots.*

THE RIGHT SALES SERVICE . . . *because the HAYDON Field Engineer in your area is a Timing Specialist fully qualified to counsel you. He's listed in your Yellow Pages. Have him come in to discuss your requirements . . . or, if you prefer, write to us direct.*

*Trademark Reg. U.S. Patent Office

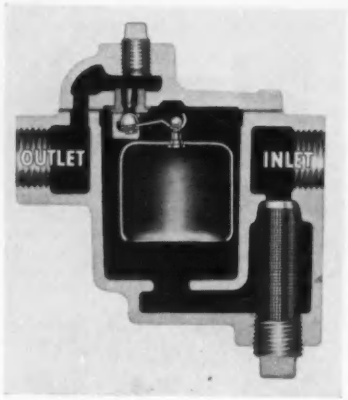
HAYDON AT TORRINGTON
HEADQUARTERS FOR TIMING

A Subsidiary of General Time Corp.

HAYDON Manufacturing Company, Inc.
3130 ELM STREET, TORRINGTON, CONN.

obtainable as partially open, open, or closed center types. The arrangement may be double-solenoid with a no-spring or spring-centered valve, or it may be a single-solenoid with a spring offset valve. Solenoids provided with the new DG series valves are for 115 v, 60 cps a-c service. Solenoid inrush current is approximately 3.2 amp, max; holding current is 0.6 amp, max, for ⅛ and ¼ in. nominal sizes. For the ½ and 1¼ in. nominal sizes, solenoid inrush current is approximately 7.5 amp, max; holding current is 0.84 amp max. Vickers Inc., Detroit 32, Mich.

For more information—
Circle 59, inside back cover



Combination Strainer Traps

These traps remove condensate and have a built-in strainer for the protection of equipment. They are of cast semi-steel construction with seats and discs made of a heat-treated stainless steel. The traps are designed for pressures up to 250 psi and temperatures to 450 deg F. Clark Mfg Co., 1830 E. 38 St., Cleveland 14, Ohio.

For more information—
Circle 60, inside back cover

Plug-In Control Systems

A method by which units for control systems can be chosen from a series of 21 standard "building block" components. The modular units are mass-produced and are hooked up merely by plug-in units which can be expanded or regrouped by semi-spe-

(Continued on page 268)

GET EXTRUDED SHAPES IN BRONZE FOUNDRY ALLOYS

Many of the commonly used foundry bronzes are now being continuously cast in "extruded shapes" in lengths up to 12 feet and in diameters up to 9 inches.

A wide variety of shapes and forms never before available in bronze makes it possible to adapt these useful alloys for applications where casting and machining costs have previously been prohibitive. Shop costs are reduced by using cast rods, tubes and shapes to replace individual castings. Asarco continuous-cast bronzes are ideally suited for machining on automatic screw machines and other high-speed modern equipment.

Practically all of the standard tin-bronze alloys, including lead, zinc and nickel-bearing varieties, are being continuously cast to size. They have consistently better uniformity and machinability for faster work and longer tool life. Physical properties are improved as much as 100 percent over similar alloys cast by other methods.

Get in touch with your nearby Asarco distributor, or write to us directly for complete information on Continuous-cast Bronze.

Continuous-Cast Products Department

AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana
WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco
IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

ASARCO

NEW submersible pump motor!

LELAND announces a new, fully U.L. Approved 60-cycle pump motor that prevents vapor-lock!

New, higher octane, more volatile gasolines pose a serious problem of vapor-lock. Or *did*. For Leland has developed a completely new submersible pump motor that allows both motor and pump to be placed right *in* the gasoline storage tank.

Leland's new explosion-proof pump motor actually uses gasoline itself for both lubrication and cooling . . . installs in existing tanks. In development and under field test for more than six years, it represents as great a step forward as did the *first* gasoline curb pump motor to receive U. L. Approval—developed by Leland over 30 years ago.

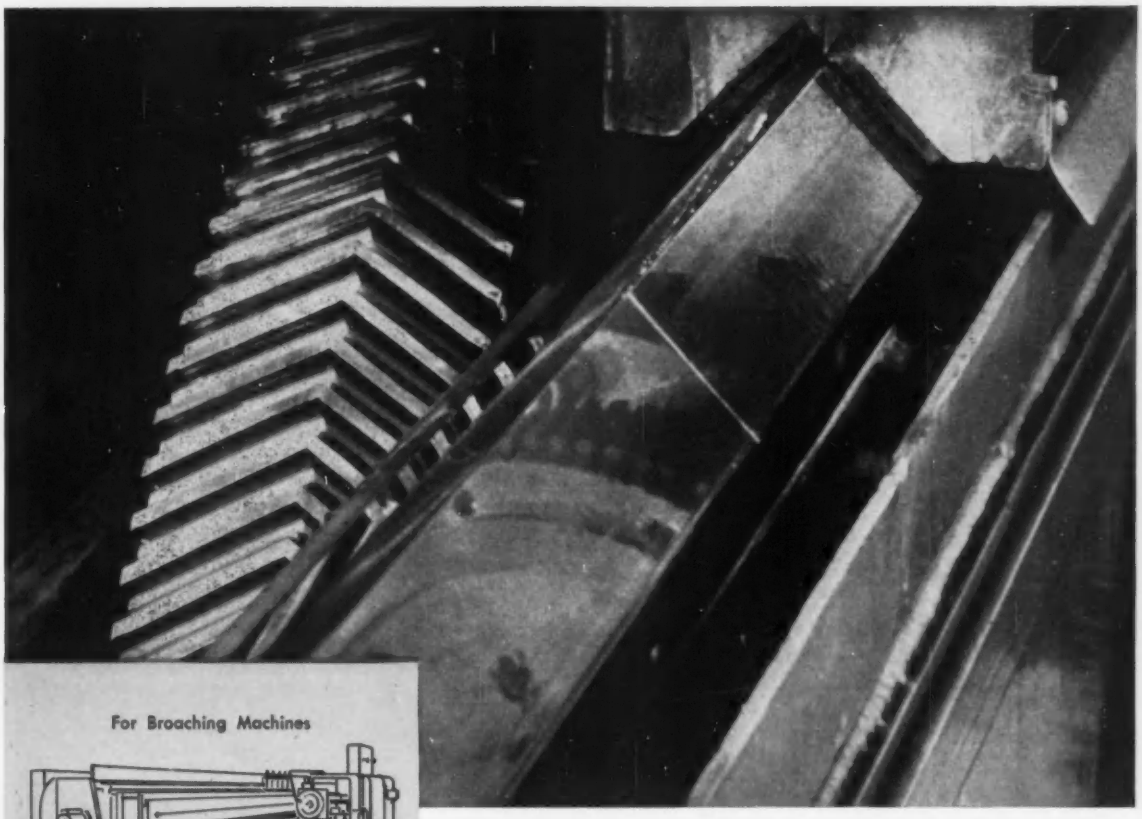
There's good reason why Leland gasoline pump motors *outsell all others combined* . . . why for explosion-proof motors of any kind, your best move is to Leland. Write, wire, or phone us today.

Leland's new 60-cycle submersible gasoline pump motor, ¾ hp, 230 V, 3450 rpm, only 3½" in dia., 17" long.

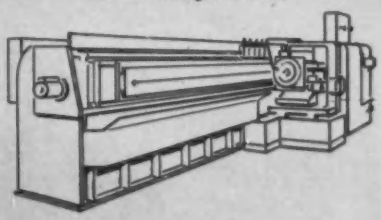
Another AMF Product

LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of AMERICAN MACHINE & FOUNDRY COMPANY

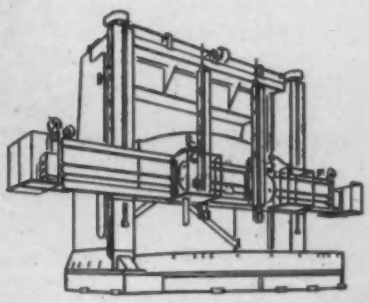


For Broaching Machines



For Heavy-Duty Lathes

For Boring Mills



. . . and for many other applications

BENEFITS OF BACKBONE

for machine-tool applications

The backbone in Farrel® herringbone gears, formed by the meeting of the two helices without a center groove, puts the *entire* face width of the gear to work. Benefit: Higher load-carrying capacity in less space—especially important in machine-tool applications. The opposed helices balance and absorb axial thrust within the gear member, preventing harmful thrust load with consequent stresses on other parts of the machinery.

The Farrel-Sykes method of gear generation assures extreme accuracy of tooth spacing, contour and helix angle. Benefit: Smooth, uniform power flow. Backlash is reduced to a minimum and the load is distributed evenly across the entire face width.

If you have a gear problem let us hear about it. Benefit: The assistance of engineers experienced in the design of gears for a wide variety of machine-tool applications.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

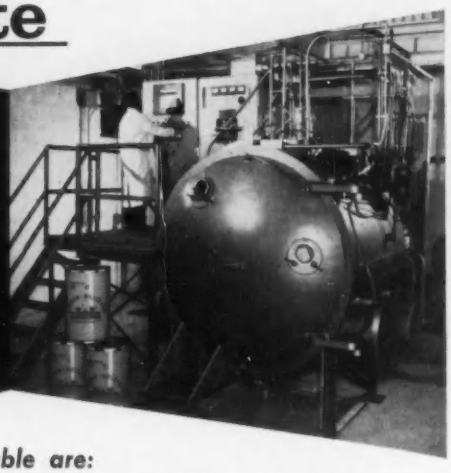
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston

Farrel-Birmingham®

FB-1830

Now...Cannon-Muskegon offers complete

VACUUM MELTING service and UltraMet alloys...



Now available are:

stainless, tool and die, magnetic steels — high-temperature, corrosion-resistant, expansion alloys — bearing steels — electrical and electronic alloys — special alloys

RIGHT NOW . . . Cannon-Muskegon provides you with a ready source of super-clean, superior strength alloys to meet complex metallurgical applications. Our completely equipped and expertly staffed vacuum melting facilities as well as chemical, physical and metallurgical laboratory can help you *find, test and produce* vacuum melted alloys for any application . . . in test or production quantities . . . with accurately predictable properties.

Ferrous, nickel and cobalt-base alloys are poured at pressures from 1 to 10 microns — resulting in extremely clean metals for smoother surfaces . . . greater tensile strength, ductility and wear life . . . and higher electrical and magnetic properties. Contact Cannon-Muskegon for facts.

We offer industry

- ***Materials for remelt*** — under conventional air melting, inert gas, vacuum.
- ***Casting development*** — includes research and experimental facilities for investment, shell mold, dry sand, and permanent mold castings.
- ***Ingots or cast billets*** — for rolling, forging or extruding in individual weights up to 250 pounds.

Finest laboratory and production equipment is used in our vacuum-melting operation . . . available to you. Let our metallurgical specialists help you solve your alloy problem.

For full particulars write for our New Bulletin on Vacuum-Melting and Air-Melting facilities, products and service.

ULTRA MET
VACUUM-MELTED ALLOYS
FOR INDUSTRY

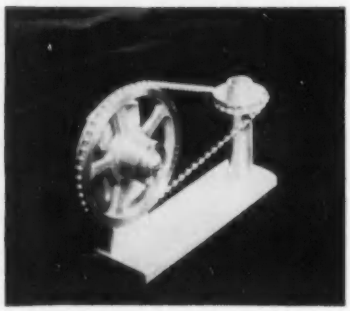
CANNON-MUSKEGON CORPORATION
2877 Lincoln Street Muskegon, Michigan

METALLURGICAL SPECIALISTS

cialist personnel. They have a single standard communications channel which can handle hundreds of control and supervisory functions, at distances up to hundreds of miles.

Five standard control systems are now available, employing the modular units: (1) automatic alarms; (2) remote metering; (3) discreet control; (4) proportional control; and (5) transmission systems. They will control processes operated electrically, mechanically, pneumatically or hydraulically; and they are sufficiently sensitive to regulate fhp motors as well as powerful enough to control 1,000 hp units or more. Sparton Control Systems Div., Sparks-Withington Co., Jackson, Mich.

For more information—
Circle 61, inside back cover



Bead Belt Drive

Drives consist of bead chain and sprockets which provide positive synchronous drives. Considerable misalignment between shafts can be tolerated, permitting a variety of configurations without resort to bevel gears, universal joints or other such devices. Sprockets are stocked for immediate delivery, for use with No. 3, 6, 10, and 13 qualified bead chain. Voland and Sons, 32 Relyea Place, New Rochelle, N. Y.

For more information—
Circle 62, inside back cover

Malfunction Detector

This detector is enclosed in oiltight JIC housing. It monitors vibration and actuates an alarm or causes shutdown when trouble occurs in rotating or reciprocating equipment. It is used to detect malfunctions such as bearing roughness, imbalance, broken

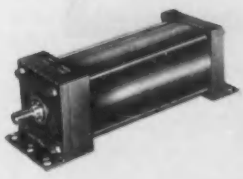
(Continued on page 272)

RIVETT FURNISHES A

complete POWER PACKAGE !

Get all your air and hydraulic needs from one source!
Over 500 standard models in all sizes for immediate delivery!

AIR CYLINDERS—168 Models



TIE ROD DESIGN

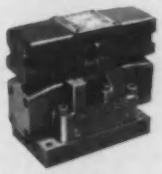
150 P.S.I. air; 250, 350, 500 P.S.I. oil. 8 mountings; 10 bore diameters; single or double end rod; internal or external thread; cushioning. J.I.C. Special covers. See Catalog 10.

KEEPER RING DESIGN

150 P.S.I. air; 300 P.S.I. oil. 7 mountings; 9 bore diameters; single or double end rod; internal or external thread; cushioning. Special covers. See Catalog 55.

HYDRAULIC VALVES—200 Models

Pipe Mounted Foot



Panel Mounted Solenoid

Panel Mounted
Pipe Mounted
Direct Control
Functional

1500 and 3000 P.S.I. Standard, spring-return, spring-centered, ball detent. All piston designs. Hand, foot, cam, solenoid, solenoid pilot, oil pilot, air pilot. ¼", ⅜", ½", ¾", 1", 1¼", 1½", 2". See Catalog 204.

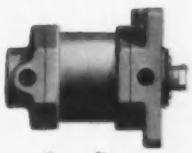
Panel valves conform to J.I.C. Greater flow; low pressure; shock resistant. Interchangeable sizes. See Catalog 261.

AIR VALVES—47 Models

Hand

150 P.S.I. 3 and 4-way. Hand, foot, cam, solenoid, and pilot. ¼", ⅜", ½", ¾" and 1". Pilot valves in side and foot mountings—palm, push-button, cam, foot, solenoid operation. See Catalog 303.

HYDRAULIC CYLINDERS—108 Models



Keeper Ring

300 and 1500 P.S.I.; 3000 P.S.I. furnished. 7 mountings; 10 bore diameters; standard and 2:1 over-size rod: single and double end rods, internal or external thread; cushioning. Special covers. See Catalog 106.

POWER UNITS—17 Models

Single Pump

1000 and 1500 P.S.I. Single pumps in six tank sizes. Capacities .4 to 40 G.P.M. Double pumps in four tank sizes with combined capacities 3.5 to 80 G.P.M.

CUSTOM-BUILT

Pressures to 5000 P.S.I. For unusual space, size, piping, valving, mounting, operation. See Catalog 400.

HANDY AIDS FOR AIR & HYDRAULIC CIRCUITS!

90 pages of working drawings, specifications; cut-away views. Get Free Copies Today!

The Better You Know Hydraulics
The Better You Like

RIVETT

RIVETT LATHE & GRINDER, INC.
Dept. PE-6 Brighton 35, Boston, Mass.

Member National Fluid Power Association

Nicholson *steam trap* capacity *gives you*...

faster, more effective condensate removal

Write, today, for your copy of new Bulletin 10-55—for detailed information.

Nicholson capacity is greater than that of any other trap of the same size. And, greater capacity—right across the board—means the Nicholson trap discharges condensate and air from steam-using equipment *faster*, more *effectively*.

- **powerful valve action—big husky bellows.**
- **positive shut-off—finely ground valve and seat.**
- **high capacity—effective use of large orifice.**
- **each unit service tested—with steam.**

When less than the best won't do, specify Nicholson.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

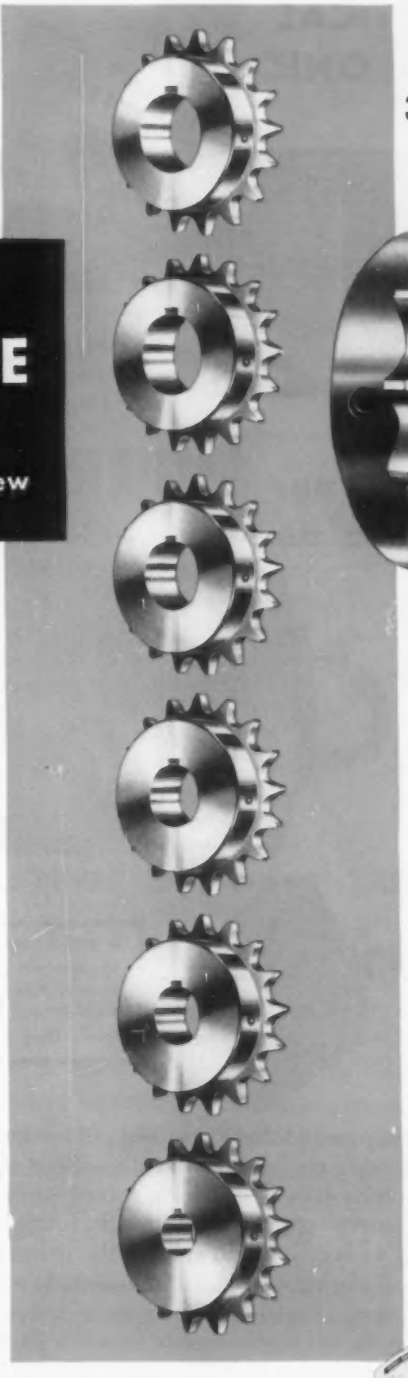
14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

NOW! – another cost-saving service from your nearby **BOSTON Gear DISTRIBUTOR**

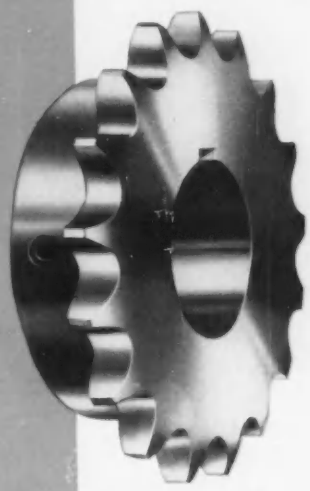
STANDARD STOCK

BORED-TO-SIZE SPROCKETS

complete with Keyway and Setscrew



76 TOOTH SIZES
321 STOCK BORES



"OFF-THE-SHELF" — AT FACTORY PRICES

FINISH BORED – READY TO INSTALL Single width steel sprockets ⅜" Pitch through 1" Pitch—in 76 commonly used Tooth Sizes —with a full selection of finished bore diameters for each sprocket—complete with keyway and setscrew.

ELIMINATE BORING EXPENSE You save expense of reboring, keyway cutting, drilling and tapping for setscrew—and avoid downtime in emergency replacements.

BOSTON GEAR QUALITY Sets the standard for precision and performance—assures longer service life for both sprockets and chain.

OFF-THE-SHELF DELIVERY More than 100 BOSTON Gear Distributors can supply BORED-TO-SIZE Sprockets from stock. Get complete information, on any question of sprocket selection or application, from factory-trained specialists . . . at the Distributor near you. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

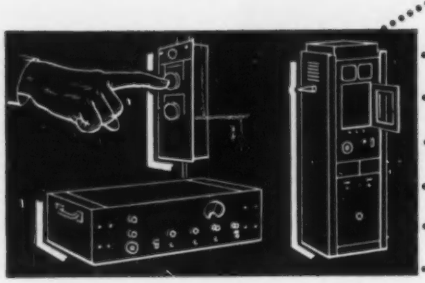
The BOSTON Gear complete line provides any Sprockets you need including SHOLD-A-GRIP interchangeable tapered Sprockets and Bushings. For complete listings, see BOSTON Gear Catalog No. 56.

CALL YOUR **BOSTON Gear** DISTRIBUTOR

For nearest Distributor, look under "GEARS" in the Yellow Pages of your Telephone Book.

56BG-S-23

ELECTRICAL / ONIC



CONTROL?
AUTOMATION?
INSPECTION?
DISTRIBUTION?
MEASURING?
TESTING?

call upon our **SUPERIOR** willingness to design

Slip Ring Assemblies that fit your job.

• *Silver alloy brushes by Superior have low contact resistance, low friction, and low noise level. They live long.*

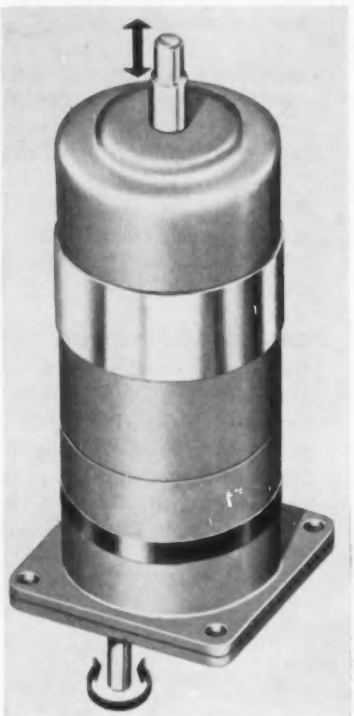
The word is getting around that Superior really welcomes an invitation to study slip ring applications. Seen above is one of many such jobs which have solved problems for the manufacturers of end products. Sometimes we build a slip ring assembly which follows the customer's design, or we will design and build an assembly which suits your equipment. Practically any size or design can be met. Let us quote you on a *complete Superior package* unit including rings, brush holders, and brushes of our own manufacture.

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE • CLEVELAND 5, OHIO

SCP SUPERIOR CARBON BRUSHES "Since 1919"

blades, bent shafts. Mechanism is fail-safe, does not depend on external power source, and requires no maintenance. Range of adjustment is 0 to 2 G. Contacts are single-pole, single-throw, and rated at 5 amp, 115-230 v, ac, resistive or inductive loads. Beta Corp., Forest Ave., at Ridge Road, Richmond 26, Va.

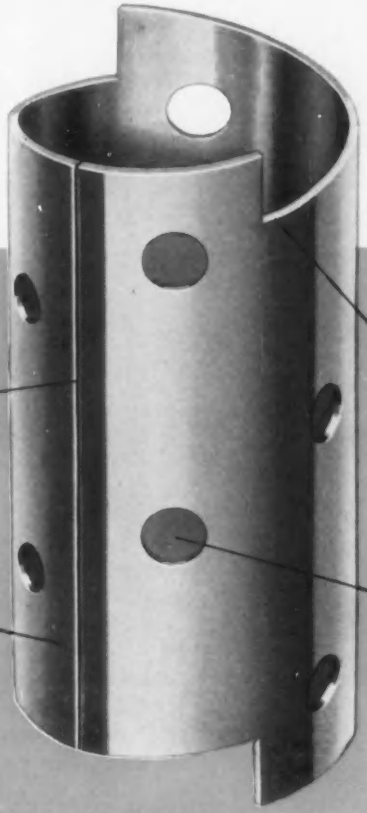
For more information—
Circle 63, inside back cover



Power Transducer

The power transducer is available in a variety of fhp sizes with a wide selection of gear train assemblies

(Continued on page 276)



Open or closed, straight or clinch butted, or special seams.

Special design features are easily incorporated in these spacers, rolled from steel strip.

Lengths from ⅛" to 5". I.D. from ⅛" to 1⅛". Any standard plating desired.

Holes, windows, cutouts or notches to meet your needs. Ball indented O. D. available.

Rolled Split Steel Spacer Tubes

Infinite Design Variations . . . for a Multitude of Industrial Jobs!

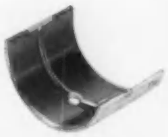
Delivered ready for assembly—no costly cut-off or de-burring. Save the cost of pipe or tubing. No scrap or material handling or inventory! You can save purchasing time, too—645 standard lengths, diameters and gauges. Special designs available. Send for free catalog and price list.

FEDERAL-MOGUL DIVISION, Federal-Mogul-Bower Bearings, Inc.
11043 Shoemaker, Detroit 13, Michigan

BEARING-SURFACED THRUST WASHERS

BABBITT-LINED BEARINGS

PLAIN & BIMETAL SPLIT BUSHINGS



COPPER-LEAD BEARINGS

FEDERAL Mogul

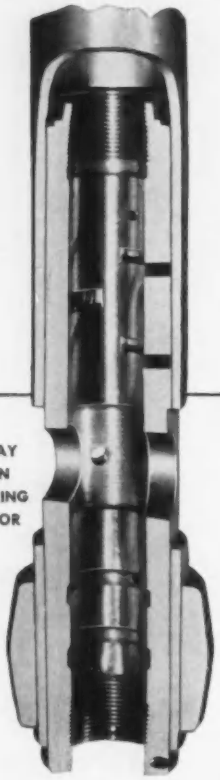
SINCE 1899

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

MICROHONING*

with self-dressing abrasives generates consistent *Functional Surface Finishes*

Microhoning, the low-velocity abrading process consistently produces part after part exactly to your specified surface finish requirements, because the abrasive grits always remain sharp.

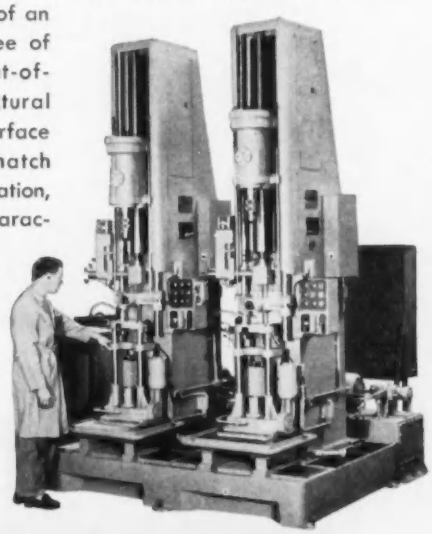


CUTAWAY SECTION OF STEERING ACTUATOR

SELF DRESSING ACTION OF THE ABRASIVES . . . is accomplished by the rotation and reciprocation of the Microhoning tool—the combined motion continuously changes the direction of force on the abrasive grits and keeps them dressed.

EFFICIENT STOCK REMOVAL . . . results from the many sharp-cutting grits acting simultaneously over a wide area of work surface. In this manner, the effect of heat is also minimized. Of all production processes, Microhoning least disturbs the sub-surface structure of the work.

FUNCTIONAL SURFACE CHARACTERISTICS . . . are obtained in one uninterrupted cycle. Microhoning generates accuracy within millionths of an inch . . . surfaces free of waviness, taper, out-of-roundness and structural stresses . . . uniform surface finish and a cross-hatch pattern for best lubrication, sealing and wear characteristics.



Monroe Auto Equipment Co. designed its power steering unit to withstand rugged use while maintaining sensitive control. In the final processing of the hydraulic steering actuator, Monroe chose Microhoning to obtain diametric accuracy, consistent finish and to generate geometric precision.

The rough and finish Microhoning operations removed .005" stock from an interrupted bore 1.125" in diameter and 6⅜" long.

MATERIAL AND HARDNESS: SAE 1118 steel, Rockwell 45-50C

TOLERANCES: size—.0003"
roundness and taper—.0001"

FINISH: 25 microinches or less

CYCLE: rough Microhoning—35 to 40 seconds
finish Microhoning—15 to 20 seconds

MACHINE: Double-column Model 740 Hydrohoner

For more details on this application write for CROSS-HATCH Vol. 8, No. 1

*MICROHONING = STOCK REMOVAL + GEOMETRY + SIZE CONTROL + SURFACE FINISH

MICROMATIC HONE CORPORATION

8100 SCHOOLCRAFT AVENUE • DETROIT 38, MICHIGAN

if you make ELECTRICAL equipment ...

you should know about SHARON SPECIAL STEELS

SHARONSTEEL

For more than 50 years Sharon has been a prime producer of the steels needed most by the electrical industry.

For such products as meters, outlet boxes, motors, controls, transformers, etc., Sharon produces hot and cold rolled special strip steels in large coils, cut lengths or sheets.

If you want exactly the right steel for the job, call in the man with experience in providing steel for the electrical industry — your Sharon Steel Salesman.

Typical products used by leading electrical manufacturers include:

STAINLESS — both straight chrome and chrome-nickel
ELECTRICAL STEELS — field, armature, electrical and motor grades
COATED STEELS — Galvanite*, Brite Zinc, Electro Galvanized Terne
FORGING INGOTS and BILLETS
SPRING STEELS — of every analysis
SHARONART — the steel with the rolled-in surface design
N.A.X. and COR-TEN — hi-tensile low-alloy steel

Electrical Manufacturers

Should Have These Booklets:

420 STAINLESS — a complete review of a popular straight chromium grade.

GALVANITE* — The story of one of the most popular hot dip zinc coated steels.

SHARONART*—Rolled-in design steels with excellent illustrations.

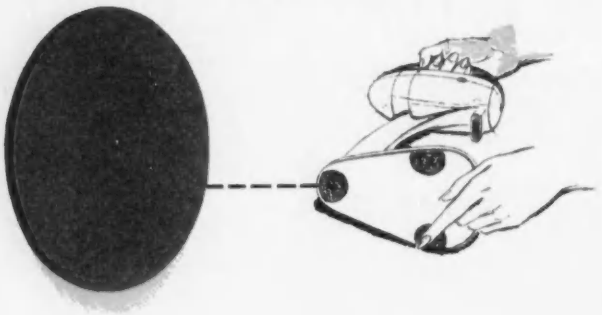
*Trademark registered by Sharon Steel Corporation

SHARON STEEL CORPORATION *Sharon, Pennsylvania*

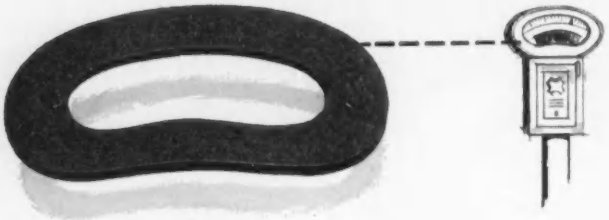
DISTRICT SALES OFFICES

CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, MONTREAL, QUE., TORONTO, ONT.

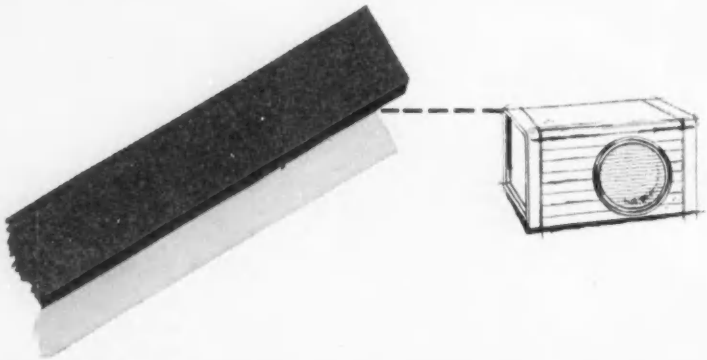
Prevents skids



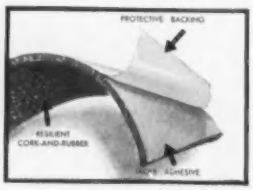
Weatherproofs



Kills noise



It's Armstrong DK-153, a resilient cork-and-sponged rubber composition backed with a pressure-sensitive adhesive. This versatile material is now being used for hundreds of different industrial jobs . . . including skid-proofing electric mixers, keeping rain and dust out of parking meters, and quieting air conditioners. You can get Armstrong DK-153 in rolls, strips, sheets, or die-cut shapes, in thicknesses from 1/32 inch to 3/16 inch, with or without adhesive backing. In any form, DK-153 is easy to apply: just peel off protective covering and press material into place. For samples, write to Armstrong Cork Company, 7306 Irvin Street, Lancaster, Pa.

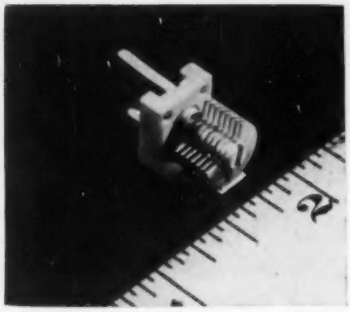


Armstrong DK-153

. . . used wherever performance counts

whereby the direction and speed of the servo can be controlled in proportion to displacement of the input shaft. The unit can be used in proportional open loop systems, or can be arranged with feedback for a closed loop system. Cedar Engineering, Inc., 5806 W. 36 St., Minneapolis 16, Minn.

For more information—
Circle 64, inside back cover



Printed Circuit Capacitors

Three miniature air dielectric trimmer capacitors are designed for tab mounting on dip-soldered printed wiring boards or screw-mounting on conventional chassis. The trimmer capacitors measure just $\frac{3}{64}$ x $\frac{7}{16}$ x $\frac{17}{32}$ in. behind mounting surface. The new trimmer capacitors have a minimum effective capacity range of 5, 10 and 15 uf. The nominal minimum capacity of the three units are 1.2, 1.2 and 1.5 uf respectively. Radio Condenser Co., Davis & Copewood St., Camden, N. J.

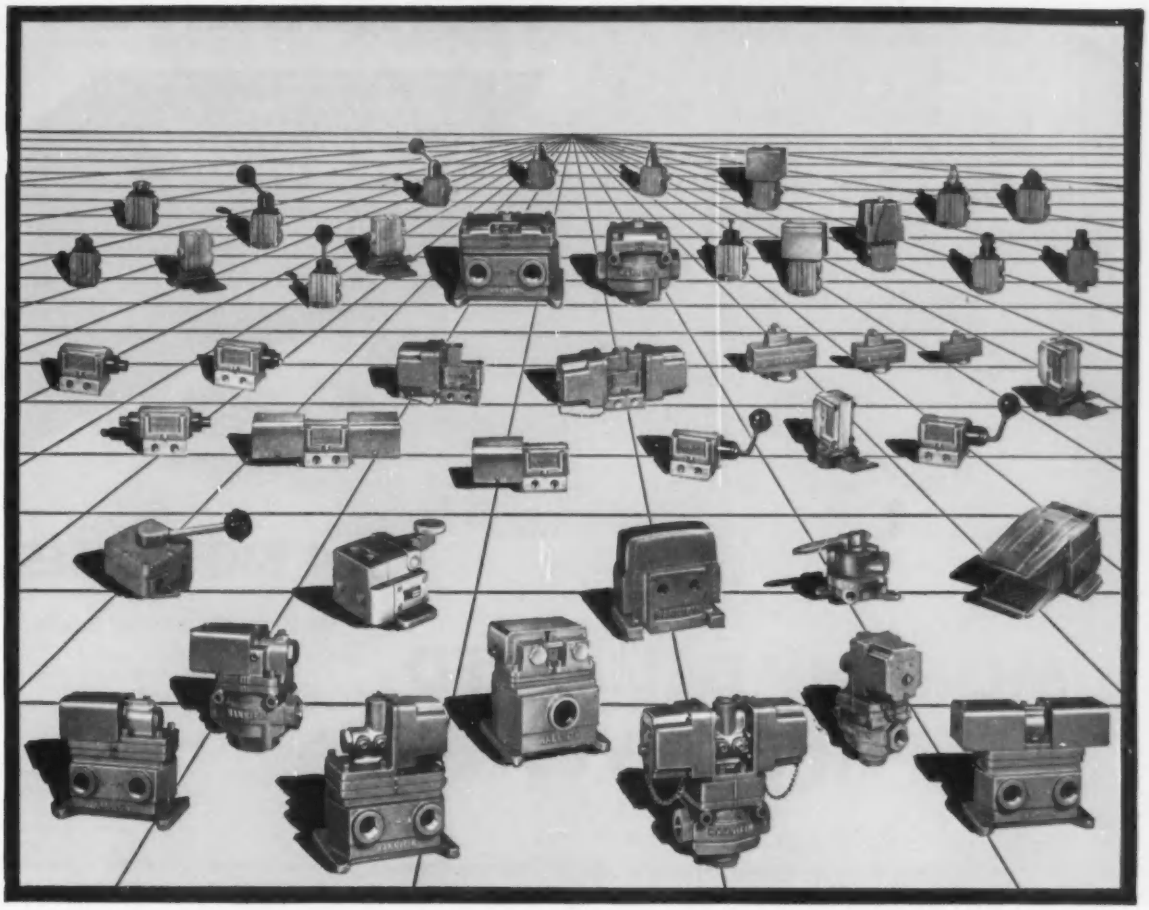
For more information—
Circle 65, inside back cover

High-Temperature Lubricating System

Centralized lubricating systems designed to withstand temperatures up to 500 F while providing fully automatic lubrication have been applied to equipment such as hot cut flare machines for the glass industry, flatwork ironers in commercial laundries, and valve stems of large industrial gas engines. The systems are made up of three basic components: 1) A combintion pump-reservoir that feeds oil at a predetermined frequency and volume into 2) a single-line distribu-

(Continued on page 280)

FOR AIR CYLINDER CONTROL... Manual or Electric



Hannifin is your best valve source

What air control valves do you need, or prefer? Hannifin has all types—for your production lines or the machines you manufacture. They include:

P-M Pilot-Master Valves, solenoid controlled by integral pilot heads (including new-type, dust-tight, splashproof heads that completely meet J.I.C. recommendations). ⅜″ to 1¼″. 2-way, 3-way and 4-way.

P-M Master Valves. ¾″ to 1¼″. 2-way, 3-way and 4-way, air operated. For remote control from a wide choice of P-M Pilot Valves.

P-M Direct-Operated Valves. For direct control of small air cylinders. 2-way, 3-way and 4-way. ¼″ and ⅜″.

Disc Valves. Rotary and sliding reciprocating disc types for hand, foot or electric operation. ⅛″ to ¾″.

Micrometric Speed Control Valves for micrometer-like speed adjustment through control of exhaust flow.

You can simplify your air control problems by standardizing on Hannifin.

Stock Delivery On All Types

HANNIFIN

MAIL THE COUPON FOR PROMPT ACTION

- ☐ Have Field Engineer call at once
- ☐ Have Field Engineer stop by soon
- ☐ For the present, just send complete Hannifin Control Valves Catalog

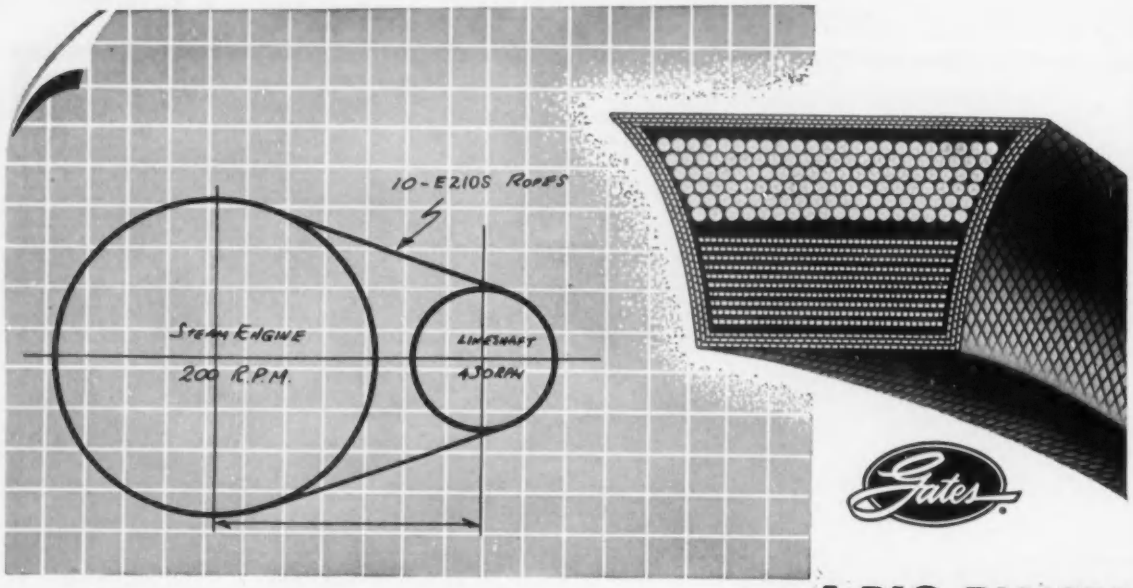
Hannifin Corporation, 525 S. Wolf Rd., Des Plaines, Illinois

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....



MORE HP DELIVERED PER $ INVESTED

On any new drive design—where you have limited space or you need to keep weight down—here is an important fact that can save you money:

A Gates Super Vulco Rope drive will deliver more horsepower per dollar invested than any standard V-belt drive.

Actually, the greater load carrying capacity of Super Vulco Ropes cuts down the number of belts required (5 Super Ropes do the work of 7 standard belts) . . . thus reducing the width of sheaves.

Sheaves with fewer grooves not only cost less, they weigh less, and take up less room—advantages that can easily improve the design and lower the overall cost.

A wealth of drive data is quickly available to you. Simply call your nearby Gates V-Belt Distributor (see 'phone book yellow pages) for a Gates V-Belt Specialist. Stocks available in industrial centers around the world. The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-Belts.*

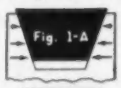
4 BIG PLUSES

✚ Handles shock loads

Super-strength cords provide 40% greater horsepower capacity . . . easily absorb heavy shock loads.

✚ Wears far longer

Concave Sidewalls (Fig. 1) increase belt life. As belt bends, concave sidewalls (U.S. Pat. No. 1813698) become straight, make uniform contact with sheave groove (Fig. 1-A). Uniform contact means less wear on sides of belt . . . longer V-belt life.



Flex-Weave cover (U. S. Pat. No. 2519590) provides greater flexibility with far less stress on fabric. Cover wears longer—increases belt life.

✚ Provides Static Safety

High electrical conductivity is built into Gates Super Vulco Ropes for safer drives (in explosive atmospheres).

✚ Resists oil, heat and weather

Special rubber compounds with which cords and fabric are impregnated make Super Vulco Ropes highly resistant to heat, oil and prolonged exposure.

TPA 76

Gates Super Vulco Rope Drives

LUBRICATION A PROBLEM?
*why not try *PUREBON . . .*

* CARBON-GRAPHITE ESPECIALLY DESIGNED FOR MECHANICAL APPLICATIONS

PROPERTIES OF PUREBON

1. **Molded to size—for many applications.**
2. **Readily machineable to any intricate shape.**
3. **Chemically inert—non-toxic, resists attack by most chemicals.**
4. **Dimensionally stable — does not warp or distort at high temperatures.**
5. **Light weight — low cost where molded to size.**
6. **Low coefficient expansion — good electrical conductivity.**

Purebon is the ideal solution to many knotty problems facing designers today involving sliding or rotating parts where lubrication is difficult or impossible. Many grades of Purebon can be run dry at temperatures as high as 1000°F. Water, acids, gasoline and jet fuels make ideal lubricants for many grades of Purebon. *(Whatever your problem, there is a grade of Purebon for its solution.)*

For complete information about Purebon, write for new Bulletin No. 55.

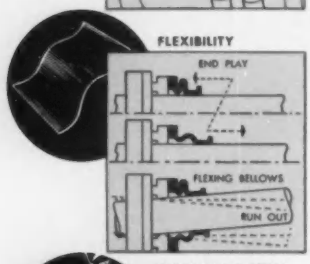
PURE CARBON CO., INC.
448 HALL AVENUE **ST. MARYS, PA.**

JOHN CRANE

Shaft Seal Design With A Purpose!

POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.



FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.

PRECISION MANUFACTURE

Leakproof performance is assured. Washer and seat surfaces are precision lapped to a perfect mate under a patented "John Crane" process.

A SEAL FOR EVERY SERVICE

All "John Crane" Seals are constructed to the particular service requirements . . . from hot or cold water to the most destructive acids, corrosives and gases . . . temperatures up to 1000°F. . . . pressures to 1200 psi. They can be furnished in types and sizes to meet practically any mechanical or dimensional condition.

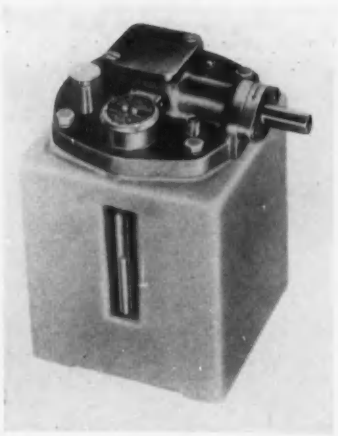
Request Bulletin S-204-2. Containing full information on "John Crane" engineered shaft seals.

GET COMPLETE DETAILS

Crane Packing Co., 6445 Oakton Street, Morton Grove, Ill. (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

CRANE PACKING COMPANY



tion system, with junctions and branch lines leading to each lubricating point where 3) a device filters and measures the oil and maintains one-direction oil flow. A sintered bronze filter material is used. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

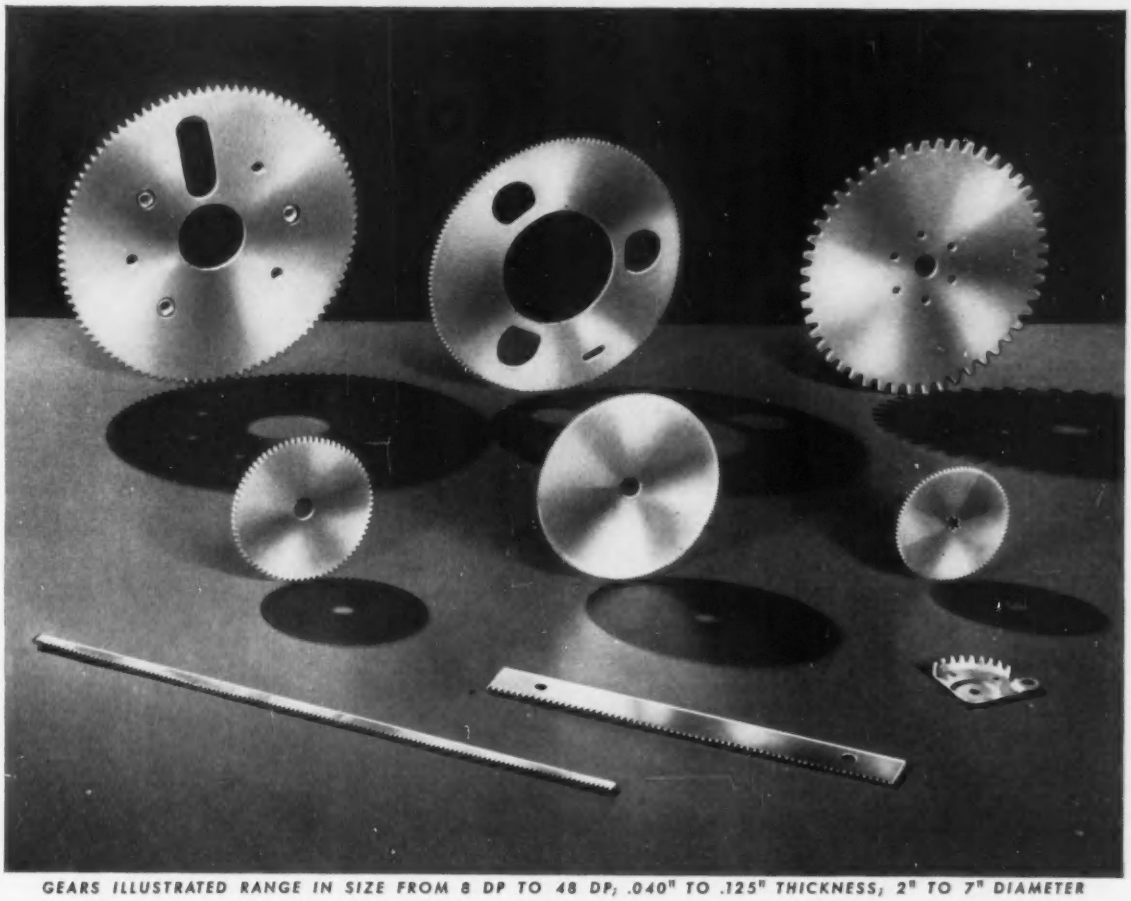
For more information—
Circle 66, inside back cover

Shock-Measuring Instrument

Originally developed for recording the accelerations experienced in the maneuvering of military aircraft or missiles, the instrument is useful wherever it is desirable to know what shocks have been encountered. A typical use is the recording of shocks experienced in shipping delicate apparatus.

Each channel can be factory-set to count at any level from 2.5 to 10 G absolute, in increments of 0.5 G min. Accuracy of setting is 0.2 G (static calibration). Frequency response is flat within 10% from zero to ten cycles per second. A standard AN fitting is provided for connecting the instrument to a 28-v, dc power sup-

(Continued on page 282)



GEARS ILLUSTRATED RANGE IN SIZE FROM 8 DP TO 48 DP; .040" TO .125" THICKNESS; 2" TO 7" DIAMETER

HOW TO CUT ASSEMBLY TIME AND GEAR COSTS!

Assembly lines *flow faster* with Winzeler Stamped Gears. Down-time headaches disappear. Finished assemblies run S-M-O-O-T-H . . quiet. And they last longer, too.

Gaining greater accuracy and all-round quality in *Stamped* Gears has been a specialty of ours for years. Improved modern methods of Tooling, Stamping, and Assembling have resulted in a new high degree of precision that remains *uniform* in high speed, mass-production runs. Regardless of the quantity of Gears you need, you can depend upon WINZELER Stamped Gears to *consistently* measure up to the most exacting specifications. Your own assembly operations will soon reflect the savings made possible by these better, more uniform Stamped Gears.

WINZELER research has cut Gear costs, too. Now, for many applications, single stampings can be laminated and indexed to produce wider faces at savings up to 60%!

We stamp Gears in production runs, in sizes from 96 to 8 dp, and from .006 to 3/16" thickness . . and up to 7" diameter. Tell us about your needs. Send drawings or descriptions today. Ideas and low cost estimates incur no obligation.

WINZELER Stamped Gears

MAIL THE COUPON FOR FREE STAMPED GEAR FOLDER

WINZELER MANUFACTURING & TOOL CO.,
1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

Gentlemen:

Please mail to me, at once, a copy of the free WINZELER Stamped Gear folder.

NAME_____

COMPANY_____

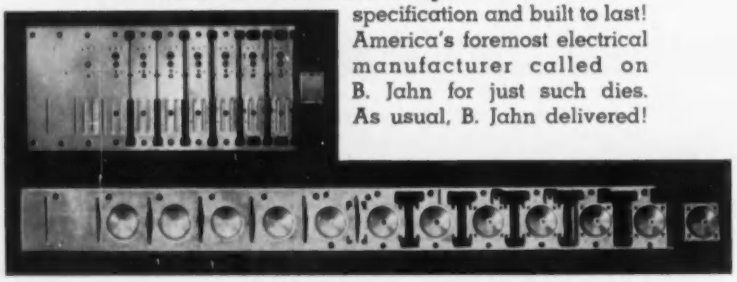
ADDRESS_____

CITY_____ ZONE____ STATE____

TO DELIVER THERMOSTAT COMPONENTS BY THE MILE, BY THE MINUTE!
PROGRESSIVE DIES by
B. Jahn

Form Intricate Parts Day After Day With Absolute Accuracy and Uniformity!

Thermostat components must be precise—identical —competitively priced—produced by the millions! That means the dies must really be built — built to specification and built to last! America's foremost electrical manufacturer called on B. Jahn for just such dies. As usual, B. Jahn delivered!



Here's a set of die strips that show how progressive dies by B. Jahn really rolled up their sleeves and went to WORK! The 9 station die delivered 60 units per minute; the 12 station die formed 90 components per minute. Both dies delivered mile after mile of intricate parts — with unfailing uniformity and precision. One more example of B. Jahn die making ingenuity and versatility affording increased production at decreased cost.

COMING SOON!

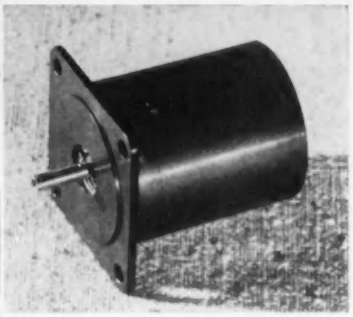
A brand new B. Jahn brochure —bigger and better than ever. Write for your copy now —you'll get it shortly.

B. Jahn

THE B. JAHN MANUFACTURING COMPANY • NEW BRITAIN, CONNECTICUT

ply. The four-channel unit draws 0.6 amp and the five-channel unit draws 0.75 amp; both ratings are maximum intermittent demands. The five-channel accelerometer is 7¼ x 2¾ x 2¾ in. and weighs 40 oz. W. L. Maxson Corp., 47-37 Austell Pl., Long Island City 1, N. Y.

For more information—
Circle 67, inside back cover



Hysteresis Synchronous Motor

A line of miniature motors developed for instrumentation where specific requirements go beyond the capabilities of the conventional synchronous motors can be supplied for either 8000, 12,000, or 24,000 rpm speeds. With suitable phasing capacitors in the circuit, these motors are adaptable for a single, two or three-phase supply. These motors are said to include exceptionally low vibration and noise level, together with smooth full torque for starting and running the load up to speed. J. B. Rea, 1723 Cloverfield Blvd., Santa Monica, Calif.

For more information—
Circle 68, inside back cover

General Purpose Time Switch

Suitable for indoor and outdoor use, the switch will turn electric circuits on or off at any time of day. It can be used to control all types of street, sign, store and flood lighting, capacitor switches, heating, air-conditioning and refrigeration equipment, irrigation and pump devices. Unit construction of the terminal block and contacts eliminates internal wiring which helps prevent hot spots and burnouts, according to the manufac-

(Continued on page 287)

Production Boom Putting on Pressure for Greater Drafting Room Output?

Now IS THE TIME TO ACT *in Behalf of Your Company and Yourself!*

Chances are that your company, like most, is gearing up for greater-than-ever production. That means more and more pressure on your drafting department for engineering drawings and prints. You owe it to your company and yourself to equip your department, right now, to meet growing demands with greater output!

New, higher-production equipment and materials can help you do it! Never has there been a better opportunity to replace old, inadequate equipment with the efficient new products you've been wanting. With management's desire for greater production, you couldn't pick a better time to get approval for new equipment expenditures.

BRUNING

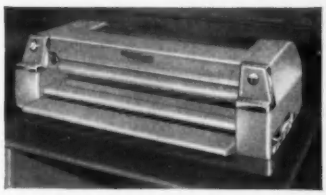
To discover for yourself how many ways you can boost drafting room output, yet save time and manpower, take a minute to look over the next three pages. You'll be glad you did!

Look How Many Ways You Save Time and Money With

Check the Places in Your Drafting Room Where Production Bottlenecks Can be Eliminated by Modern Bruning Products!

(1) Modern Copyflex Machines Speed Reproduction, Cut Operating Costs

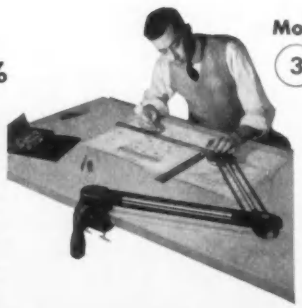
Five new and advanced machine models introduced in just the last year! They offer you all the benefits of diazo black-on-white reproduction, plus problem-free installation and operation. No fumes, no exhaust ducts. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. There's a Copyflex model to meet every need. New, better Copyflex sensitized materials work together with Copyflex machines to give you premium results.



JUST OUT! New Tabletop Model 300 with 30-inch printing width! Now the smallest engineering department can afford the advantages of "inside" reproduction with low-cost Model 300. The largest company can economically supplement its reproduction center with additional, strategically located Model 300s.

(2) Modern Bruning Drafters Speed Drafting up to 30%

Over conventional equipment, Bruning drafters speed drafting up to 30% on most jobs . . . up to 40% on some structural drawings. Patented "Equipoise" gravity compensator, exclusive touch control indexing provide unrivalled simplicity, precision, and ease of operation. Full range of models including Counterbalanced and Track Drafters. Standard or Civil Engineer protractor heads.



Modern Bruning Tracing Mediums (3) Speed Drawings, Enable Sharper Prints

These improved drawing mediums are unsurpassed for translucency, pencil-and-ink taking qualities, and permanence. You make drawings and tracings far easier and faster, get cleaner and sharper prints. Select from a complete variety.

Production Boom Putting on Pressure for Greater Drafting Room Output?

Now IS THE TIME TO ACT *in Behalf of Your Company and Yourself!*

Chances are that your company, like most, is gearing up for greater-than-ever production. That means more and more pressure on your drafting department for engineering drawings and prints. You owe it to your company and yourself to equip your department, right now, to meet growing demands with greater output!

New, higher-production equipment and materials can help you do it! Never has there been a better opportunity to replace old, inadequate equipment with the efficient new products you've been wanting. With management's desire for greater production, you couldn't pick a better time to get approval for new equipment expenditures.

BRUNING

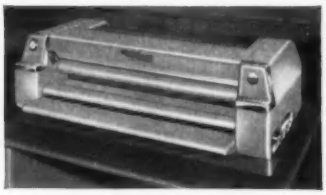
To discover for yourself how many ways you can boost drafting room output, yet save time and manpower, take a minute to look over the next three pages. You'll be glad you did!

Look How Many Ways You Save Time and Money With

Check the Places in Your Drafting Room Where Production Bottlenecks Can be Eliminated by Modern Bruning Products!

(1) Modern Copyflex Machines Speed Reproduction, Cut Operating Costs

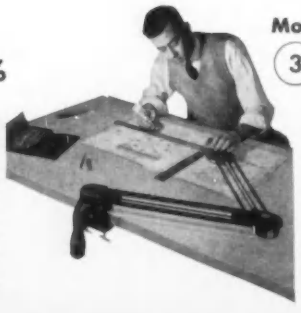
Five new and advanced machine models introduced in just the last year! They offer you all the benefits of diazo black-on-white reproduction, plus problem-free installation and operation. No fumes, no exhaust ducts. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. There's a Copyflex model to meet every need. New, better Copyflex sensitized materials work together with Copyflex machines to give you premium results.



JUST OUT! New Tabletop Model 300 with 30-inch printing width! Now the smallest engineering department can afford the advantages of "inside" reproduction with low-cost Model 300. The largest company can economically supplement its reproduction center with additional, strategically located Model 300s.

(2) Modern Bruning Drafters Speed Drafting up to 30%

Over conventional equipment, Bruning drafters speed drafting up to 30% on most jobs . . . up to 40% on some structural drawings. Patented "Equipoise" gravity compensator, exclusive touch control indexing provide unrivalled simplicity, precision, and ease of operation. Full range of models including Counterbalanced and Track Drafters. Standard or Civil Engineer protractor heads.



Modern Bruning Tracing Mediums (3) Speed Drawings, Enable Sharper Prints

These improved drawing mediums are unsurpassed for translucency, pencil-and-ink taking qualities, and permanence. You make drawings and tracings far easier and faster, get cleaner and sharper prints. Select from a complete variety.

Can Boost Drafting Room Output, New, Modern Bruning Products!

Why Let Old and Inadequate Equipment and Materials Stall Operations Now, When More and More Output Is Demanded of Your Department? Every Day You Delay Is Costing You Time and Money!

Here are the modern, higher-production products—some the newest on the market—that can help you boost drafting room output by replacing old and inadequate equipment and materials. A pioneer researcher in its field, Bruning still leads the way today with such developments as newly improved tracing papers and cloths that are setting a new standard in their field . . . newly improved sensitized materials that give you quality reproduction never before attainable . . . new, improved Copyflex machines that set a new high in quality, convenience, and economy of reproduction.

Researcher, manufacturer, and supplier . . . Bruning provides you a single, convenient, dependable source for everything you need in top-quality drafting room supplies and service. You simplify ordering and stocking, save time and money. Companion products, like Copyflex reproduction machines and Copyflex sensitized materials, are made to work together to give you premium results.

4 Modern Hamilton Drafting Tables Provide up to 50% More Use of Floor Space

You can put six Hamilton Auto-Shift tables where you now have four boards with separate reference desks. The unique design of Auto-Shift increases the efficiency of draftsmen, reduces waste motion and fatigue. Bruning has a modern drafting table to suit every need and budget.

5 Modern Hamilton UnitSystem Files Save Time, Space; Permit Orderly Expansion

You choose the individual filing units you need and combine them in an integrated and interlocking stack. You save time because drawings are easier to file and find. You make the most efficient use of space, expand your filing set-up in an orderly fashion.

More Products from Bruning to Help You Step up Production, Save Time and Money!

Modern Drafting Tools and Supplies Help Speed Draftsmen's Work

Bruning's wide selection includes not only standard items, but many special time-saving aids such as dotting pens, proportional dividers, planimeters, and Wrico lettering sets.

Modern Bruning Erasing Machines Save Hours of Manual Erasing

Do a neater, safer erasing job. Save hours of finger-cramping manual erasing. Patented hollow shaft permits use of extra-long, seven-inch eraser, prevents "fly-outs." Quiet, cool, vibration-free.

BRUNING *Gives You More to Help Boost Output*

3 More Reasons

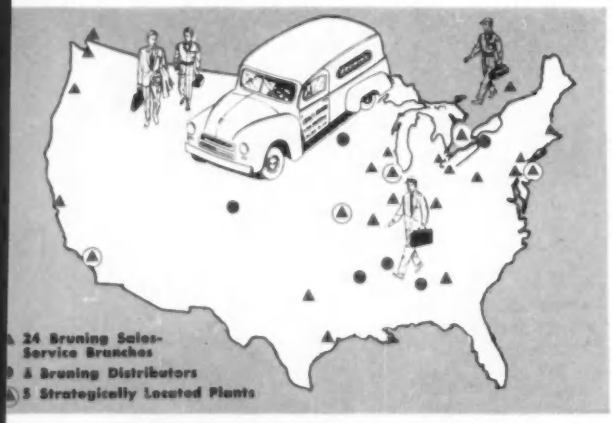
Why You Can Depend on Bruning to Help You Boost Drafting Room Output, Save Time and Money!

New and Better Products
—from Bruning Research and Engineering

In the past, it was Bruning Research and Engineering that introduced the first pencil tracing cloths, the first fume-free whiteprinters in America, the first band-type drafting machines. Today, by virtue of its modern laboratories and large engineering staffs, Bruning still leads the way in the development of new and better products. In just the past year, Bruning introduced five new, advanced reproduction machines . . . many newly improved tracing materials.

Consistently High Quality
—from Bruning Manufacturing

In its own modern paper converting plants at Teterboro, N. J., Chicago, Kansas City, Los Angeles, and Toronto, Ontario, Bruning controls quality all the way to bring you tracing mediums and sensitized materials of dependable, consistent high quality. The famous Copyflex reproduction machines are entirely Bruning manufactured to provide you the finest in reproduction performance.



The Product and Help You Need When You Need Them—from Bruning Sales Service

With the most comprehensive network of sales-service branches, distributors, and plants in its field, Bruning assures you of prompt, dependable service and supply. Your nearby Bruning branch is headquarters for a capable staff of Bruning sales-service specialists who are immediately available to you. Your nearby Bruning branch or distributor carries a full line of Bruning products and is staffed and equipped to give you fast, efficient supply. You suffer no costly delays for lack of supply or service.

America's Leading Supplier of
Engineering and Drafting Equipment

BRUNING

There you have it—the "big package" from Bruning to help you meet the demand for greater drafting room output! You get a complete line of modern, high quality products! You get better service. They work together to bring you better results at lower cost.

Charles Bruning Company, Incorporated
4700 Montrose Avenue, Chicago 41, Illinois
In Canada: Charles Bruning Company (Canada) Ltd.
105 Church Street, Toronto 1, Ont.

Printed in U.S.A.

Can Boost Drafting Room Output, New, Modern Bruning Products!

Why Let Old and Inadequate Equipment and Materials Stall Operations Now, When More and More Output Is Demanded of Your Department? Every Day You Delay Is Costing You Time and Money!

Here are the modern, higher-production products—some the newest on the market—that can help you boost drafting room output by replacing old and inadequate equipment and materials. A pioneer researcher in its field, Bruning still leads the way today with such developments as newly improved tracing papers and cloths that are setting a new standard in their field . . . newly improved sensitized materials that give you quality reproduction never before attainable . . . new, improved Copyflex machines that set a new high in quality, convenience, and economy of reproduction.

Researcher, manufacturer, and supplier . . . Bruning provides you a single, convenient, dependable source for everything you need in top-quality drafting room supplies and service. You simplify ordering and stocking, save time and money. Companion products, like Copyflex reproduction machines and Copyflex sensitized materials, are made to work together to give you premium results.

4 Modern Hamilton Drafting Tables Provide up to 50% More Use of Floor Space

You can put six Hamilton Auto-Shift tables where you now have four boards with separate reference desks. The unique design of Auto-Shift increases the efficiency of draftsmen, reduces waste motion and fatigue. Bruning has a modern drafting table to suit every need and budget.

5 Modern Hamilton UnitSystem Files Save Time, Space; Permit Orderly Expansion

You choose the individual filing units you need and combine them in an integrated and interlocking stack. You save time because drawings are easier to file and find. You make the most efficient use of space, expand your filing set-up in an orderly fashion.

More Products from Bruning to Help You Step up Production, Save Time and Money!

Modern Drafting Tools and Supplies Help Speed Draftsmen's Work

Bruning's wide selection includes not only standard items, but many special time-saving aids such as dotting pens, proportional dividers, planimeters, and Wrico lettering sets.

Modern Bruning Erasing Machines Save Hours of Manual Erasing

Do a neater, safer erasing job. Save hours of finger-cramping manual erasing. Patented hollow shaft permits use of extra-long, seven-inch eraser, prevents "fly-outs." Quiet, cool, vibration-free.

BRUNING *Gives You More to Help Boost Output*

3 More Reasons

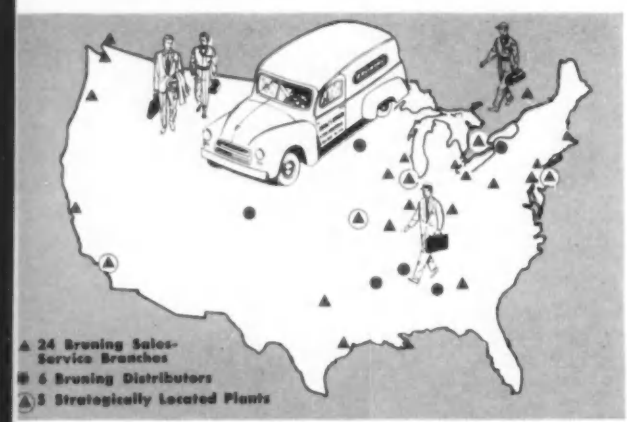
Why You Can Depend on Bruning to Help You Boost Drafting Room Output, Save Time and Money!

New and Better Products
—from Bruning Research and Engineering

In the past, it was Bruning Research and Engineering that introduced the first pencil tracing cloths, the first fume-free whiteprinters in America, the first band-type drafting machines. Today, by virtue of its modern laboratories and large engineering staffs, Bruning still leads the way in the development of new and better products. In just the past year, Bruning introduced five new, advanced reproduction machines . . . many newly improved tracing materials.

Consistently High Quality
—from Bruning Manufacturing

In its own modern paper converting plants at Teterboro, N. J., Chicago, Kansas City, Los Angeles, and Toronto, Ontario, Bruning controls quality all the way to bring you tracing mediums and sensitized materials of dependable, consistent high quality. The famous Copyflex reproduction machines are entirely Bruning manufactured to provide you the finest in reproduction performance.



The Product and Help You Need When You Need Them—from Bruning Sales Service

With the most comprehensive network of sales-service branches, distributors, and plants in its field, Bruning assures you of prompt, dependable service and supply. Your nearby Bruning branch is headquarters for a capable staff of Bruning sales-service specialists who are immediately available to you. Your nearby Bruning branch or distributor carries a full line of Bruning products and is staffed and equipped to give you fast, efficient supply. You suffer no costly delays for lack of supply or service.

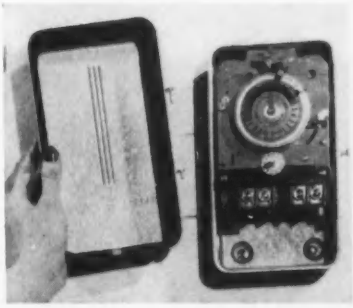
America's Leading Supplier of
Engineering and Drafting Equipment

BRUNING

There you have it—the "big package" from Bruning to help you meet the demand for greater drafting room output! You get a complete line of modern, high quality products! You get better service. They work together to bring you better results at lower cost.

Charles Bruning Company, Incorporated
4700 Montrose Avenue, Chicago 41, Illinois
In Canada: Charles Bruning Company (Canada) Ltd.
105 Church Street, Toronto 1, Ont.

Printed in U.S.A.



turer. With the terminal shield in place, adjustments may be made to the trippers or the time set without the possibility of accidental contact with the terminals.

The time switch has a 4 w motor with permanent silicone-grease lubricant sealed in for increased longevity and improved efficiency in a wide temperature range. The motor has positive operation from −50 F to 150 F. Operating voltage is 120, 240 and 480 v, ac. Frequency is 60, 50, and 25 cps. The timer weighs 4¾ lb and its dimensions are 9$\frac{13}{16}$ x 6$\frac{5}{32}$ x 1$\frac{1}{2}$ in. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 69, inside back cover

Anchor Nuts For Elevated Temperatures

Anchor nuts suitable for use up to 900 F are available in both miniature and regular size configurations. These nuts possess non-magnetic properties and are particularly suitable for use in electronic devices, aircraft equipment. The fastenings are presently produced in tap sizes No. 6-32, 8-32, and 10-32. Kaynar Co., Box 2001 Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 70, inside back cover

Transformer For 24 V Circuits

A transformer for 24-v control circuits has 115-v primary and 24-v secondary leads, so that all splices can be placed within one outlet box.

The transformer is designed for industrial or commercial circuits requiring a normal reactance trans-

(Continued on page 290)

Planning **THE SHAPE** *of things* **TO COME**

MANY GOOD NEW PRODUCTS coming off the drawing board will be better and cost less because Ⓑ Special Fasteners are included in their design. By paying attention to this one relatively small detail, manufacturers are able to cut assembly costs; produce products that meet and beat competition.

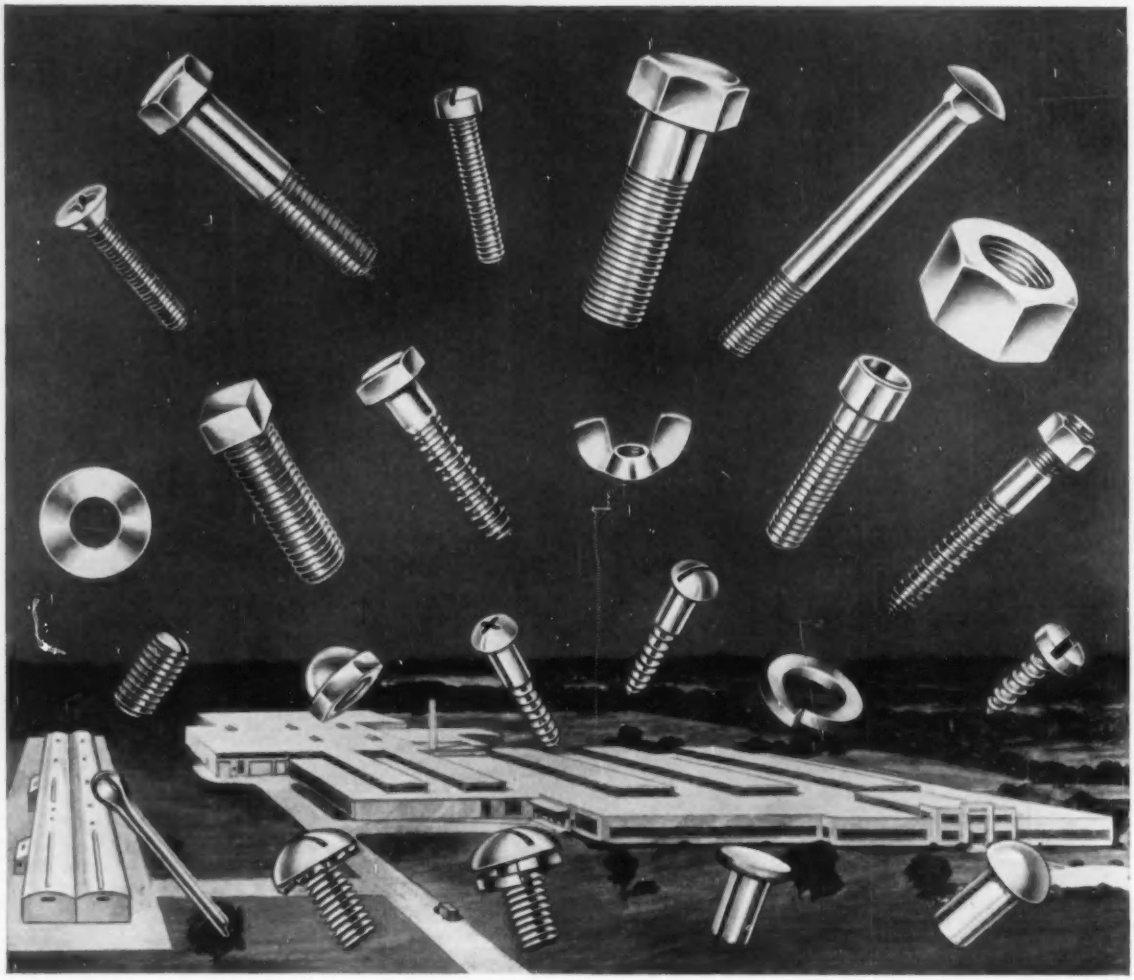
THAT'S WHY it will pay you to discuss your fastener problems with an experienced concern such as Buffalo Bolt. Simply phone or write one of our offices. No obligation, of course.

BUFFALO BOLT COMPANY
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

• *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* Ⓑ **SPECIAL FASTENERS**



HARPER...a better source for STAINLESS
and at no added cost

Here are the reasons why stainless bolts, nuts, screws, washers and rivets by Harper will mean longer life, improved appearance to the equipment you make.

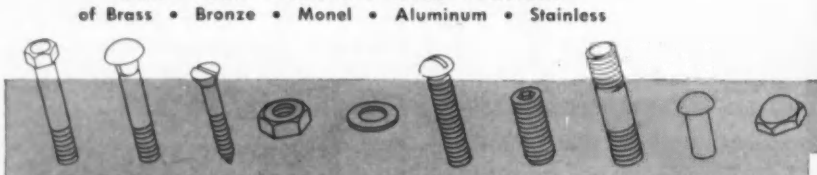
- Stronger in tensile
- Higher in yield strength
- Higher in nickel content
- More corrosion resistant
- Engineered to highest standards

You get all these Harper advantages at no added cost. Whether your order is large or small, it will be filled immediately from stock or promptly from the mill.

Your Harper distributor has a wide range of highest quality stainless steel fastenings in stock. Call him today or write us for Catalog 26.

Branch Offices in Principal Cities
THE H. M. HARPER COMPANY
8203 Lehigh Avenue, Morton Grove, Ill.

Specialists in all corrosion-resistant fastenings
Bolts • Nuts • Screws • Rivets • Washers
of Brass • Bronze • Monel • Aluminum • Stainless



OVER 7000 ITEMS IN STOCK...HARPER DISTRIBUTORS EVERYWHERE

HARPER
Everlasting Fastenings

Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, ITALY, AND GERMANY

Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness and passed

through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Norgren MICRO-FOG LUBRICATORS

with Maximum Capacities of 32, 200, 300 and 1000 Bearing Inches*

for

BEARINGS • GEARS • CHAINS
SLIDES • CAMS • WAYS
OTHER MACHINE COMPONENTS

The Most Complete Equipment Line for Effective Lubrication.

⅓ Pt. Oil Capacity

Model 30-40-2S — ¼" pipe size. 32 Bearing Inch Capacity.
Model 30-40-3S — ⅜" pipe size. 32 Bearing Inch Capacity.

½ Pt. Oil Capacity

Model 30-41-2S — ¼" pipe size. 32 Bearing Inch Capacity.

1 Qt. Oil Capacity

Model S3406-2S — ¼" pipe size. 32 Bearing Inch Capacity.
Model S3406-6S — ¾" pipe size. 200 Bearing Inch Capacity.
Model S3406-8S — 1" pipe size. 300 Bearing Inch Capacity.

1¾ Gal. Oil Capacity

Model X3400-2S — ¼" pipe size. 32 Bearing Inch Capacity.
Model X3400-6S — ¾" pipe size. 200 Bearing Inch Capacity.
Model X3400-8S — 1" pipe size. 300 Bearing Inch Capacity.

4½ Gal. Oil Capacity

Model Y3400-2S — ¼" pipe size. 32 Bearing Inch Capacity.
Model Y3400-6S — ¾" pipe size. 200 Bearing Inch Capacity.
Model Y3400-8S — 1" pipe size. 300 Bearing Inch Capacity.

Model 33AF-16

1,000 Bearing Inch Capacity.
2 Gal. Oil Reservoir

*For complete data on bearing inch ratings and applications, write for Norgren Blueprints MF-10 and MF-20.

C.A. Norgren CO.

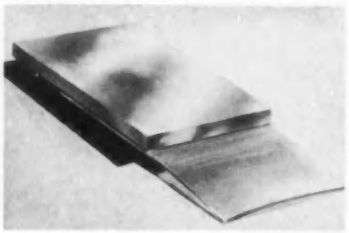
3428 So. Elati St., Englewood, Colo.

Without obligation, learn how Norgren MICRO-FOG Lubricators can provide more efficient lubrication and reduce costs in your plant. Call your nearby Norgren Representative listed in your telephone directory—or **WRITE THE FACTORY FOR NEW No. 700 CATALOG.**

Pioneer and Leader in Oil-Fog Lubrication Since 1930

former supplying 24 v with 60 cps frequency. There are two models with capacities of 50 and 85 va, respectively. Warren Webster & Co., Camden 5, N. J.

For more information—
Circle 71, inside back cover



Fluorothene Sheets For Bonding to Other Materials

Specially-treated on one or both sides, this material can be cemented to steel, aluminum, wood, plastics, cardboard or rubber. Available in thicknesses ranging from 0.005 to 0.015-in., in widths up to 16 in. Thicknesses range from 0.015 to 0.250 in. Shamban Engineering Co., 11617 W. Jefferson Blvd., Culver City, Calif.

For more information—
Circle 72, inside back cover

Pneumatic Drafting Template and Booklet

The 40 pp booklet has a well-organized compilation of all JIC symbols. The simplified drawings in each category may be used to designate pneumatic equipment, and the drafting template guide which accompanies the booklet is for drafting the desired symbols. Ross Operating Valve Co., 120 E. Golden Gate Road, Detroit 3, Mich.

For more information—
Circle 73, inside back cover

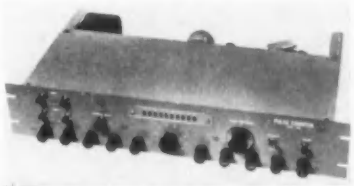
Sub-Fhp Straight Motors

The motor has an input of 115 v, input frequency of 60 cps; motor speed is 3200 rpm (based on 3.5 mfd capacitor). Output rating is 1/75 hp, permissible duty, 20 per cent duty cycle, 3 min continuous running time. Weight is 2 lb, 6 oz; three-wire unidirectional or four-wire reversing.

(Continued on page 291)

Motor shaft is ⅜ in. max OD, available in any length. Janette Electric Mfg. Co., Morton Grove, Ill.

For more information—
Circle 74, inside back cover



Variable Scale Counter

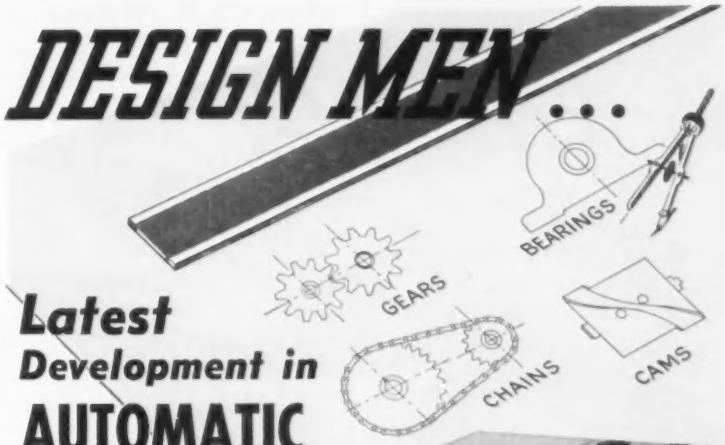
A variable scale counter is said to be applicable to any counting need, whether it be for a present counter, a burst counter, a scaler or an adder. Each count is represented visually by means of a neon indicator, and also electronically in the form of a dc signal, allowing the unit to act also as a sorter, a pulse distributor, a converter or a coding device. The counter input accepts 0.1 microsec, 30 v pulses, amplifies and standardizes them, and then applies these pulses to the grids of a beam switching tube where they are counted at speeds from pushbutton to 500kc. Designed for standard relay rack mounting, the counter measures 19 x 3½ x 10 in. Burroughs Corp., Detroit 32, Mich.

For more information—
Circle 75, inside back cover

Table Model Whiteprinters

These 42 in. whiteprinters will expose and develop ammonia type whiteprints up to 32 fpm. One model has automatic copy separations, making it

(Continued on page 292)



Latest Development in
AUTOMATIC LUBRICATION

Norgren MICRO-FOG

Model 33AF-16
Lubro-Control Unit
For 1,000 Bearing Inches or less

Gives you these advantages

Only One Lubricator for 1,000 Bearing Inches—The 33AF-16 automatically creates a finely divided air-borne oil fog which can be appropriately distributed to all lubrication points of even large machines.

Better Lubrication—Continuously applies a protective film of oil—just the right amount, not too much, not too little—for the most efficient lubrication of machine components. Never periods of insufficient or excessive lubrication.

Oil Always Fresh, Clean—No recirculation of deteriorated or contaminated lubricant to increase wear or corrosion.

Big Savings Through Manifolding—MICRO-FOG can be manifolded the extent of any machine, greatly reducing the number of distribution lines or the number of lubricators required.

Eliminates Expensive High Pressure Piping—MICRO-FOG Lubricators operate at pressures in the neighborhood of only one p.s.i.

Big Savings in Equipment—Banishes large lubricant reservoirs, pumps, drainage and return lines, and elaborate filters of flood recirculating systems.

Lower Bearing Temperatures—Maintains lower operating temperatures of high speed rotating parts and eliminates heat from fluid friction generated by parts churning in lubricant.

Protection From Coolant and Dust—The slight air pressure in bearing housings prevents entry of coolant, abrasive dust or other foreign material.

No Oil Seals Required—Oil seals are eliminated at all lubrication points served by MICRO-FOG, reducing seal maintenance and machine downtime.

Visual Oil Feed—An oil feed dome provides a quick visual indication of proper operation of lubricator.

Automatic Alarm Controls—Switches are provided to actuate an alarm system or controls to warn of conditions affecting proper lubrication.

Space-Saving—Only 12" x 11" x 9" in size, this lubricator contains all necessary controls plus a 2-gallon oil reservoir.

Oil-Saving—Spraying makes every particle of oil do a more thorough lubrication job. The 2-gallon reservoir holds enough oil for hours of continuous lubrication.

For complete data on Norgren MICRO-FOG 33AF-16 Lubro-Control Unit, call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY FOR BULLETIN 531.

C. A. Norgren Co.
3428 So. Elati St., Englewood, Colorado

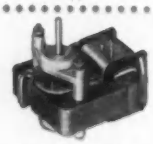
Pioneer and Leader in Oil-Fog Lubrication Since 1930

RELY on GI . . .

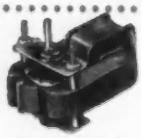
for smooth, effortless performance, just one of the reasons why manufacturers

SPECIFY GI FRACTIONAL HP MOTORS

MODEL B
4-pole, 4-coil shaded pole AC Induction Type



MODEL A
2-pole, shaded pole AC Induction Type



MODEL C
2-pole, shaded pole AC Induction Type

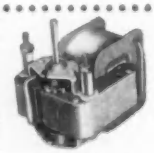
■ For really smooth, silent operation, GI fractional hp motors have no equal — that's why original equipment manufacturers have been relying on GI 1/40 hp to 1/1100 hp motors for over 25 years. Leading manufacturers have proved to themselves that GI motors are unexcelled in the industry. They appreciate General Industries free design consultation service and prompt deliveries, too. When **you** have a fractional hp requirement, you'll find that your best bet is to — RELY on GI!

Write for complete specifications and quantity-price quotations.

MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

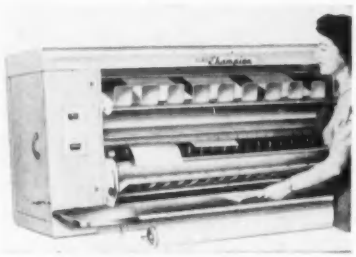
MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)



MODEL F
2-pole, shaded pole AC Induction Type

THE GENERAL INDUSTRIES CO.

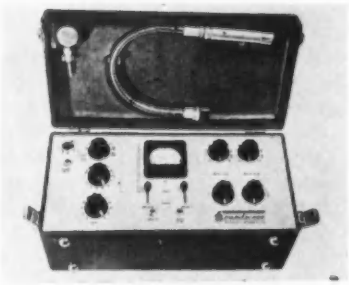
DEPARTMENT GK • ELYRIA, OHIO



a one-step feed machine. The other requires manual copy separation, resulting in two-step feed operation.

Both models have a 3000 w mercury lamp for rapid printing. The ammonia developer has a stainless steel perforated plate with slip screen and ribbed rubber sealing sleeve to convey prints through ammonia chamber. Full strength 26 deg ammonia is used. These whiteprinters will reproduce any translucent copy, such as engineering drawings, tracings, maps, film, letters, office forms. C. F. Pease Co., 3816 N. Rockwell St., Chicago 18, Ill.

For more information—
Circle 76, inside back cover



Measures, Analyzes Noise

This instrument can be used to measure overall noise in a manner similar to a sound level meter. It can be used to analyze this sound as an octave band analyzer and it can function as a narrow band analyzer. It also has a built-in oscillator which serves as a source for an electrical and an acoustical calibrator. The 14 subminiature vacuum tubes used throughout the instrument have relatively low current drain, so the minimum of space is required for circuit components and batteries. To further reduce size, printed circuits are used in all amplifier and anode follower circuits.

To make an overall sound pressure

(Continued on page 296)

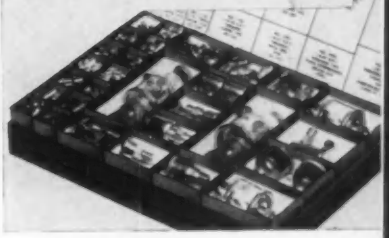
Design "Low Cost" Into YOUR Equipment

GITS

World's Largest Selection of Low-Cost Lubricating Devices

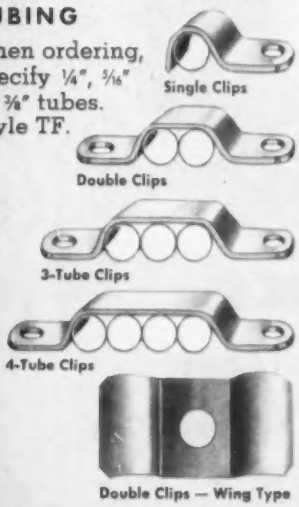
LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

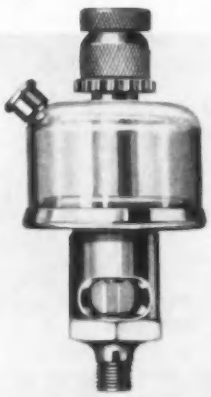
Special Introductory Price
Just **$14.95** F.O.B. Factory
Satisfaction or your money back



CLIPS FOR ATTACHING TUBING

When ordering, specify ¼", 5/16" or ⅜" tubes. Style TF.





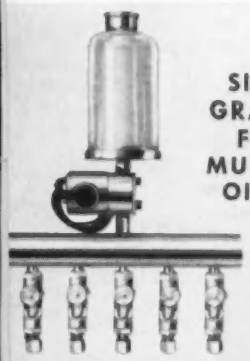
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem.

Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

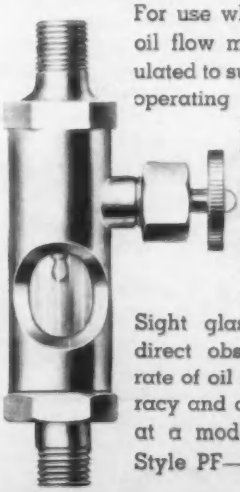
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.
The Standard For Industry For Almost Half A Century
1838-A South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"

TDA® BRAKES

if it rotates...we can control it!

...for every industrial application where heavy duty braking is required!

FSH... FLOATING SHOE HYDRAULIC BRAKE

designed for close control with heavy loads

This rugged, new, long-lasting brake is designed specifically to meet the most exacting needs of industry. Its remarkable design offers high performance with complete control. The FSH was originally designed to meet certain government specifications *so demanding* that no existing brake could fill the bill. Now it is available in a wide range of sizes for dependable control application on industrial, construction and materials handling equipment.

Unequalled stopping power and outstanding control are obtainable with the FSH. The brake shoes operate with a floating action. This permits the shoes to center themselves in the drum... eliminates the danger of liner loads concentrating at one point. The result of this even load distribution is a highly dependable, controllable brake... *in either direction* of travel. This is most important when handling heavy loads under conditions requiring maximum control.

Other outstanding features offered by this new Timken-Detroit® FSH Brake:

Mechanical Parking Brake Hook-up. A separate parking brake is no longer necessary with FSH. If specified, the FSH Brake can be furnished with a mechanical parking brake linkage.

Long-Life Lining. Brake lining is bonded to the shoe to give maximum lining area.

Positive Automatic Adjustment for special applications. One application of the foot pedal sets the automatic adjustment. No further adjustment of the brake is required during the full life of the brake lining.

Positive Contact Drum Seal. For applications where a sealed brake is required, the FSH is designed to incorporate a seal between the brake backing plate and brake drum.

For additional information . . . contact the Timken Brake Division. Complete specifications and information on the FSH Brake are available.

For every industrial, agricultural or automotive application where braking is required!

TIMKEN Detroit BRAKES

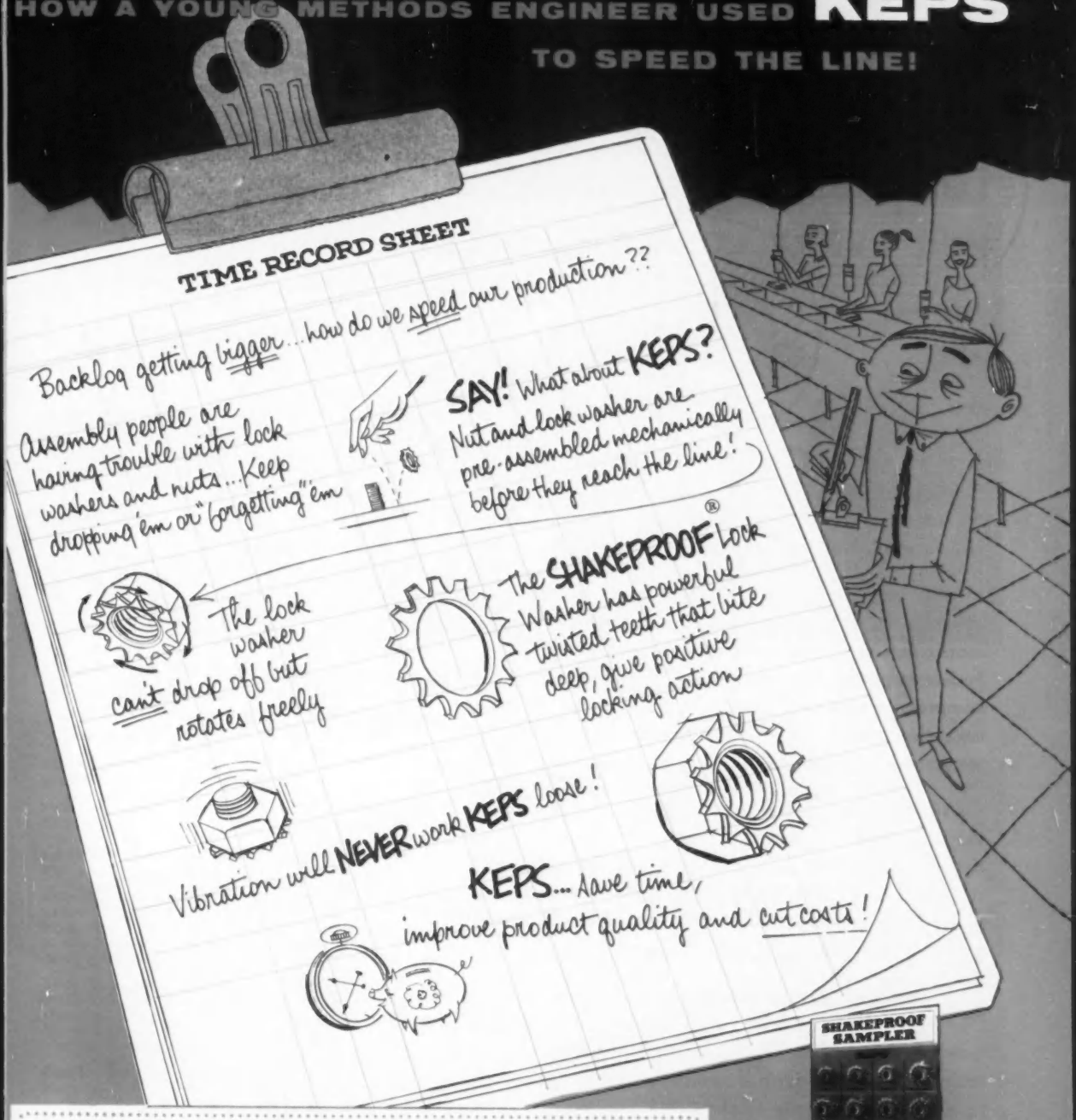
TIMKEN-DETROIT BRAKE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ASHTABULA, OHIO

Accepted T D A Standard

©1956, R S & A Company

TDA Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

HOW A YOUNG METHODS ENGINEER USED KEPS® TO SPEED THE LINE!


TIME RECORD SHEET
Backlog getting bigger...how do we speed our production??
Assembly people are having trouble with lock washers and nuts...Keep dropping 'em or "forgetting" 'em
SAY! What about KEPS? Nut and lock washer are pre-assembled mechanically before they reach the line!
The lock washer can't drop off but rotates freely
The SHAKEPROOF® Lock Washer has powerful twisted teeth that bite deep, give positive locking action
Vibration will NEVER work KEPS loose!
KEPS... save time, improve product quality and cut costs!
SHAKEPROOF SAMPLER

SHAKEPROOF

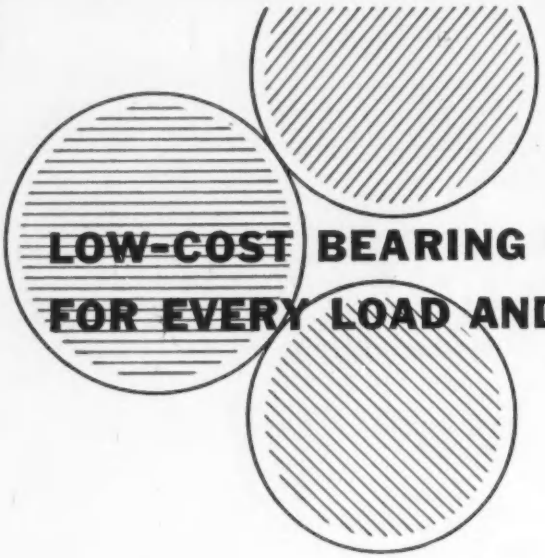
"Fastening Headquarters"®

St. Charles Road, Elgin Illinois • Offices in Principal Cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

SEND FOR FREE "SHAKEPROOF SAMPLER" . . . contains Keps samples and helpful assembly suggestions.

SHAKEPROOF
FASTEX

DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings



Copper alloys are traditional for friction bearings. There is at least one suitable for almost every kind of bearing application.

The familiar leaded bearing bronzes are easy to machine, and the soft lead in the hard copper-tin matrix acts as a lubricant under severe conditions. Federated copper-tin alloys have high compression strength. Aluminum bronzes withstand exceptional loads, speeds and temperatures and stand up well in difficult sliding operations.

Babbitts, which are bearing alloys having a tin or lead base, and which are bonded to a steel or bronze shell, offer good frictional properties, excellent running-in properties and good behavior where lubrication is poor or unreliable. Federated research has provided many improved babbitts for modern bearing service.

If your problem is the design of a low-cost friction bearing, Federated may be able to give you valuable suggestions. Our metallurgists work with many kinds of non-ferrous metals, and they know how to alloy them correctly to obtain the specific physical characteristics you require.

Federated Metals

DIVISION OF AMERICAN SMELTING AND REFINING COMPANY
120 BROADWAY, NEW YORK 5, N. Y.
In Canada: Federated Metals Canada, Ltd., Toronto and Montreal

Aluminum, Anodes, Babbitts, Brass, Bronze, Die Casting Metals, Lead, Lead Products, Magnesium, Solders, Type Metals, Zinc Dust

level measurement, the function switch is turned to an "operate" position and the power-meter control to "overall." The "overall" attenuator is turned until the meter reads on scale. The overall sound pressure level is the algebraic sum of the attenuator setting and the meter reading.

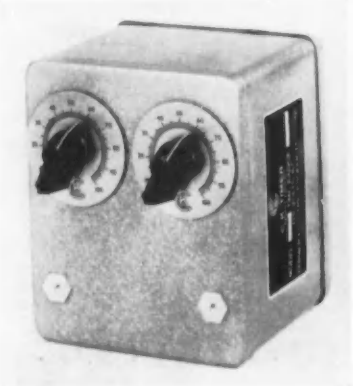
To analyze a noise, the power meter switch is turned to the analyzer position and the low and high frequency cutoff controls are adjusted to pass the frequency band that is to be measured. A frequency cutoff is selected by adjusting the product of the two low, or high, frequency cut off controls. For example, if an octave band control (upper) is set on 300 and the corresponding narrow band control (directly below) is on 1.0, the cutoff frequently will be 300. If the narrow band control is moved to 2.0, the cutoff frequency will be changed to 600. Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

For more information—
Circle 77, inside back cover

Tracing Vellum

A tracing vellum with better erasability is treated with all-synthetic resins rather than oils. Frederick Post Co., 3666 N. Avondale Ave., Chicago 18, Ill.

For more information—
Circle 78, inside back cover



Recycling Electronic Timer

This timer is a fully enclosed unit with independently adjustable time ranges for both on and off cycles of

(Continued on page 300)

MAGNETO DESIGN SERVICE

Call on Fairbanks-Morse for help in solving your magneto ignition problems!

YOU CAN PROFIT many ways by submitting your magneto ignition problems to Fairbanks-Morse engineers.

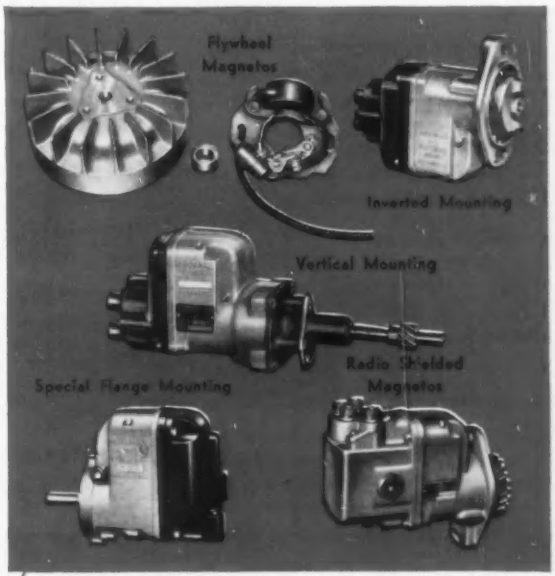
First, you get improved product performance because Super-Spark magnetos are tailored to fit your equipment and give you the kind of dependability; easy starting; simple, rugged design; and economical performance you *and your customers* expect.

But Fairbanks-Morse offers more than engineering advances and precision manufacturing. The wide selection of more than 400 different magnetos in our line enables us to use standard components, keeping manufacturing costs down and giving you higher quality at a lower price.

Your new product plans are always treated in complete confidence. Only the men working on your project know about it. And . . . after design and field testing, Fairbanks-Morse is equipped to manufacture and ship in accordance with your schedule requirements.

Also important to you and your customers . . . Fairbanks-Morse assumes complete responsibility, from design studies to field service. More than 2,500 authorized service stations throughout America are equipped to handle repairs, replacements, and parts for more than 3,500,000 Super-Spark magnetos now in use.

So, whatever your special requirements may be: radio shielding, fungus protection, special mounting, flywheel application, heavy-duty design, or extra voltage output — call on Fairbanks-Morse for expert engineering and complete follow-through! Write to Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin, for Bulletin FM75F.



MORE THAN 3,500,000 MAGNETOS IN THE FIELD

FAIRBANKS-MORSE

A name worth remembering when you want the BEST

MAGNETOS • REWIND STARTERS • WATER SYSTEMS • GENERATING SETS
PUMPS • MOTORS • SCALES • DIESEL LOCOMOTIVES AND ENGINES

M-R-C 9000 series BALL BEARINGS

originated by M-R-C and manufactured for 38 years—

ideal for applications requiring maximum thrust capacity in both directions, in single-row bearing space.

Advantages of the M-R-C 9000 Series Ball Bearings:

— Equal thrust capacity in both directions.

— Provide maximum load carrying through optimum ball complement.

— Often permit replacement of duplex pair of bearings with single bearing.

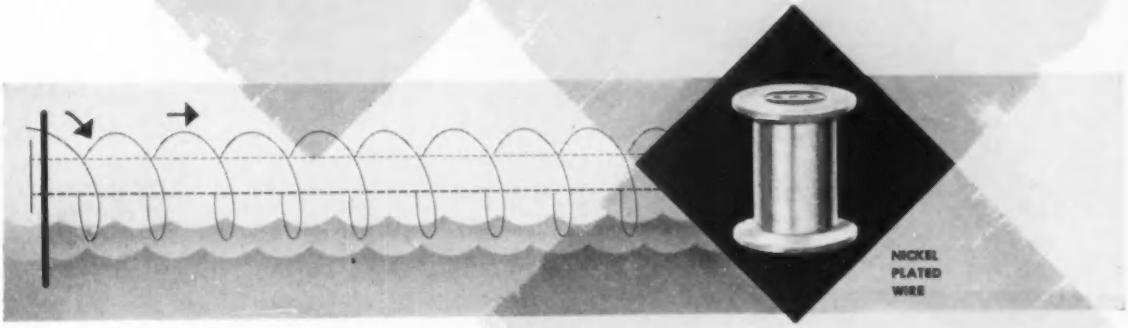
M-R-C Engineers are available for consultation on your bearing problems.

M-R-C Strom SRB GURNEY BALL BEARINGS

MARLIN ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, NEW YORK

Nickel plated copper is just one of the many special wire composites developed by Sylvania to meet exacting wire requirements.

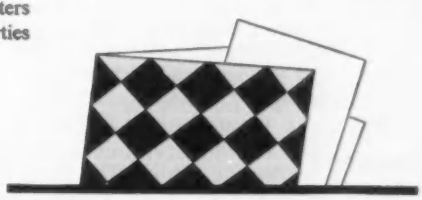


Sylvania **composite wire** offers high conductivity at higher operating temperatures

DO YOU HAVE AN APPLICATION for a high conducting wire that can withstand higher temperatures? If so, Sylvania's nickel plated wire can offer the right solution, at the right price.

Here is a wire which has conductivity approximating that of copper, yet will withstand operating temperatures up to 150° C higher than copper.

Nickel plated copper is just one of many special cold-drawn wires developed by Sylvania. If your interests include other than magnet wire types, it will help you to know that Sylvania is one of the nation's top custom platers of wire. Depending on the properties you want, Sylvania can custom plate wire in ranges from "flash" to 20% by weight in a wide range of materials and supply it in sizes from .250 to .002. Your custom wire can be clad, too, in just about any combination of materials.



Special Wire is an important phase of Sylvania's unique service to product designers. For the complete story write for the Wire Facilities brochure. It's included in Sylvania's "Portfolio of 4-way service to designers." Address Dept. F33S.

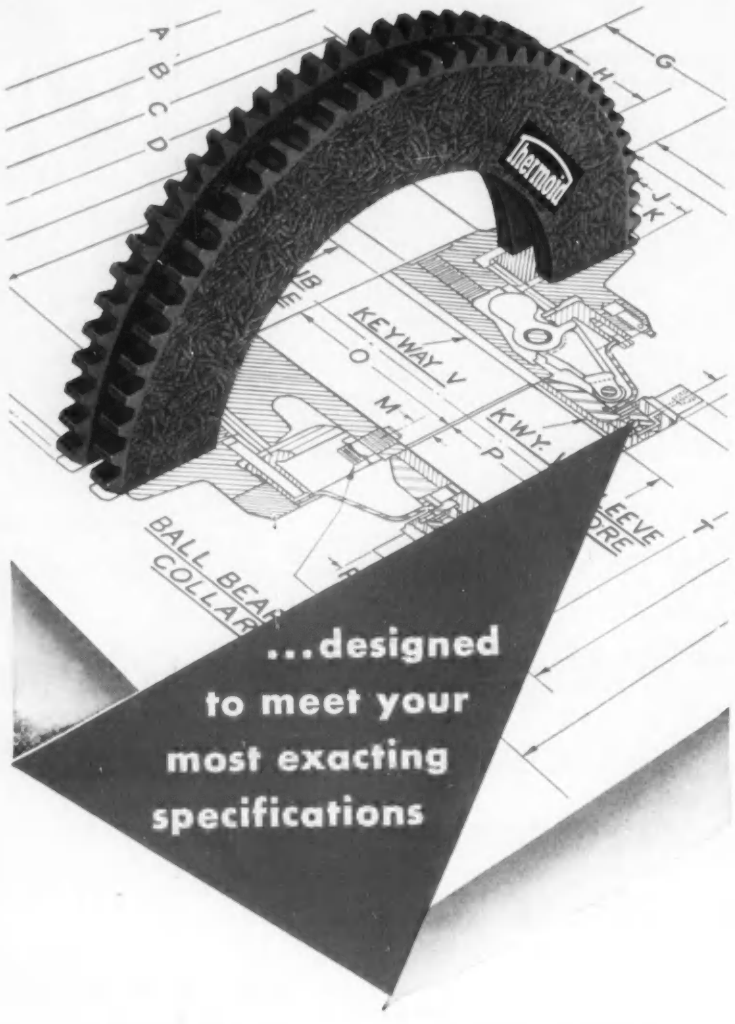
PARTS DIVISION

metal stamping | special wire | molded plastic | electronic parts

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY



Thermoid Friction Materials fit into your designs perfectly because they're custom-engineered to your exact specifications.

In Clutches manufactured by Twin Disc Clutch Co., Racine, Wisc., two Thermoid Clutch Facings, developed from superior compounds, provide smooth, positive engagement with minimum wear.

Leading manufacturers coast to coast have found it pays to specify Thermoid Friction Materials—not only for quality, but for Thermoid's *Personalized Engineering Service*. Thermoid is big enough to handle mass production demands . . . small enough to assure close liaison with your engineering staff.

Look to Thermoid, too, for Fan Belts, FHP Belts, Flat Belting, Radiator Hose and Hose of any type—designed to fit your most exacting requirements.

Thermoid

Thermoid Company
Original Equipment Division
Trenton, New Jersey

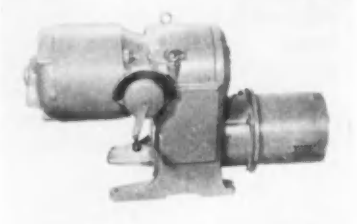
1.5, 3, 6, and 12 sec (standard). It can easily be converted to a single time-cycle operation by the removal of one tube from the unit. Instant starting cold-cathode tubes are said to require no warm-up time. Single-pole double-throw load contacts are rated for 8 amp, 115 v, a-c operation, (25 to 400 cps). The timer is 5 x 4¼ x 3¾ in. deep. Farmer Electric Products Co., Inc., 2300 Washington St., Newton Lower Falls, Mass.

For more information—
Circle 79, inside back cover

Hermetic Power Transformers

The 14 standardized items in this series employ a tapped high voltage winding to provide either of two output voltages. Detailed ratings are provided for both condenser and choke input filter circuits as well as for military and industrial applications. The 14 types provide for d-c output voltages ranging from 180 to 650 v and currents ranging from 20 ma to 420 ma. Adequate filament windings are provided to cover multiple electronic applications where high reliability is essential. United Transformer Co., 150 Varick St., New York 13, N. Y.

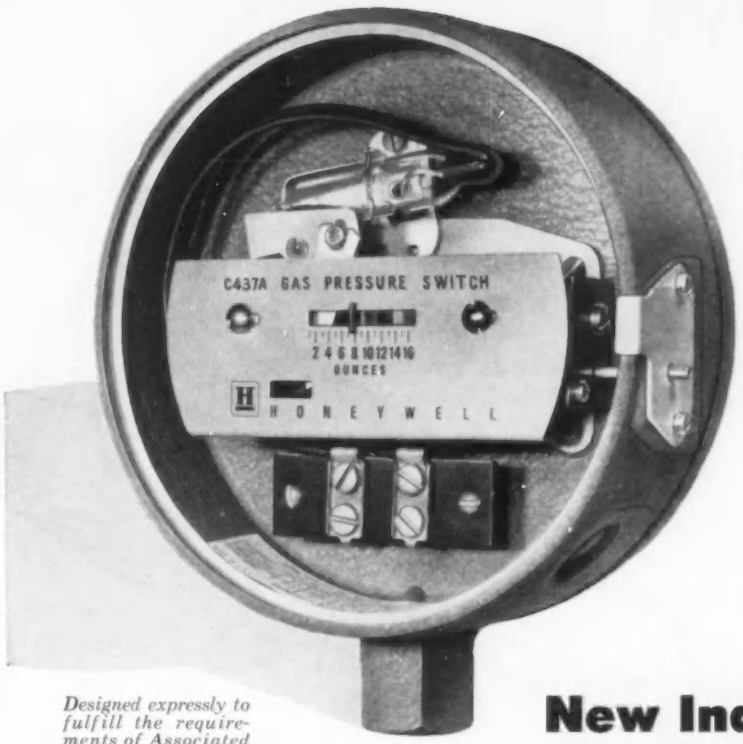
For more information—
Circle 80, inside back cover



Synchronized Multiple Drive System

The heart of the system is a specially designed power unit which interlocks motors by means of electrical impulses. Turning the control dial on the power unit varies the speed of every motor in the system equally and simultaneously. Motors are of the a-c, squirrel-cage induction type, connected to the power unit by means of standard three-phase circuitry.

(Continued on page 303)



Designed expressly to fulfill the requirements of Associated Factory Mutual and Underwriters' Laboratories.

New Industrial Gas Pressure Switch offers 4 exclusive safety features

USE this new Honeywell C437A Industrial Pressure Switch as a safety cutoff on multiple burner gas installations . . . as a pressure controller for hazardous gases . . . or as a differential controller for air or non-hazardous gases. It's simply designed, yet provides complete protection.

The C437A Industrial Gas Pressure Switch has these exclusive safety features:

1. Sealed Pressure Chamber—Should the diaphragm rupture from over pressure or any other cause, gas can't escape into the switch compartment or to the atmosphere. The pressure chamber is fitted with a pipe tap to permit venting to the stack.

2. Protected Settings—All adjustments are inside the case for protection against careless or accidental manipulation. A metal plate on the side of the case must be removed before changes in adjustment can be made.

3. Ever-Visible Switch Position and Control Settings—The entire cover of the pressure switch is a window. Position of the mercury switch and adjustment of the control settings can be determined at a glance.

4. Lockout Mechanism—An optional safety feature, when manual resetting is desired. The lockout mechanism prevents the switch from remaking contact after pressure has once dropped below the setpoint . . . even though pressure returns to normal. The lockout release button is the only adjustment that can be manipulated without removal of the protecting metal plate.

For complete information, call the nearest Honeywell office. A Honeywell sales engineer is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:**

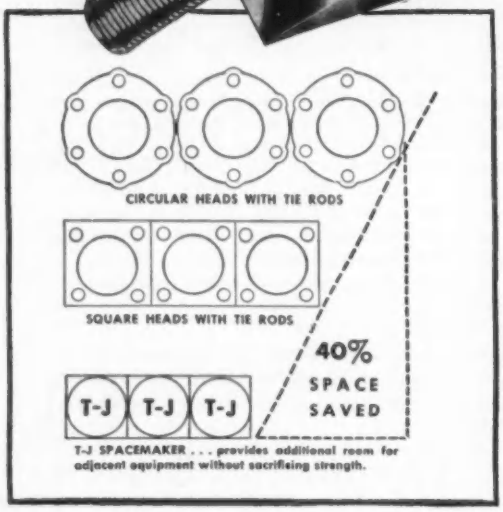
Send for Specification S1011-1 Honeywell Gas Pressure Switch C437A

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

Saves 40% Space!

STRONGER, TOO

Than Outmoded Tie Rod Cylinders!



Only T-J Spacemaker CYLINDERS

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost).
- OIL pressure to 750—AIR to 200 P.S.I.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write The Tomkins-Johnson Co., Jackson, Mich.

NEW LITERATURE . . . send today for new Bulletin with complete details of Spacemaker line.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

T-J TOMKINS-JOHNSON

RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

Enclosures available include drip-proof, totally-enclosed and explosion-proof designs. Speeds of from 1 to 10,000 rpm are available in ratios of up to 5:1, and higher speed ratios can be supplied. Motors can be furnished from ¼ to 25 hp at maximum rpm. Varidyne power units are available to carry from 1 to 50 hp connected load. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 81, inside back cover

Automatic Transmission For Small Engines

A two-speed transmission for small gasoline engines is dependent on the engine speed alone. One control, the accelerator, accomplishes the shifting.

Low speed is one-half engine speed. High speed is 80 per cent of engine speed. Trimatic Drive is adaptable to all makes and models up to 3 hp at 3600 rpm. Triune Products Co., 23350 Edward St., Dearborn 7, Mich.

For more information—
Circle 82, inside back cover

Analog-to-Digital Converter

An automatic instrument for precise high-speed measurement and digital recording of outputs from low voltage transducers in both aircraft and ground operations measures d-c voltages with resolution of 12½ microvolt, by means of a digital scanning technique. Unknown voltage is compared with standard reference voltage through the use of 12 digital scanning units; a thirteenth indicates polarity. All scanning units are modular.

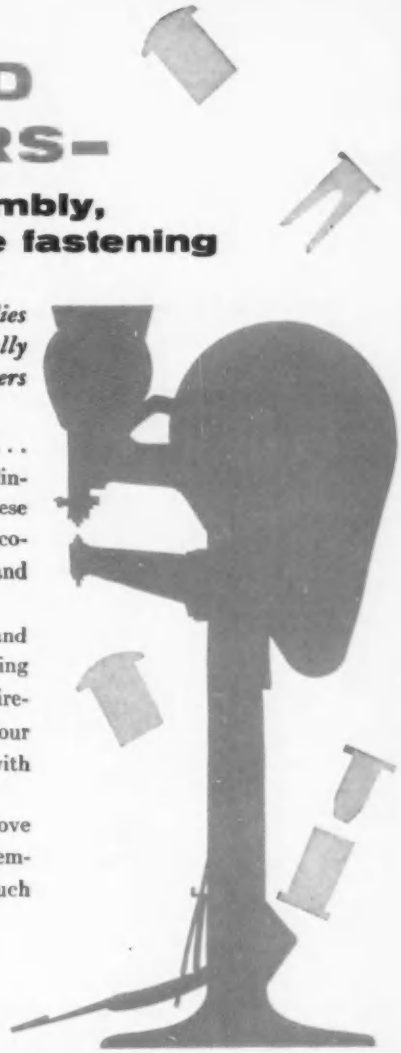
This new instrument counts at a

(Continued on page 306)

MILFORD RIVETERS—

for faster assembly, for dependable fastening

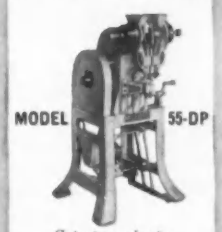
Fasten a wide range of assemblies Safely—Rapidly—Automatically with Milford Rivets and Riveters



Delicate wrist watch bracelets . . . rugged, heavy-duty truck brake lining—a wide range of parts like these are being fastened safely and economically with Milford Rivets and Rivet-Setting Machines.

Call on Milford's versatility and skill to adapt a basic rivet-setting machine to your particular requirements—call on Milford to solve your fastening problems and come up with substantial savings.

To cut production costs, improve product appearance, fasten assemblies automatically—get in touch with Milford!



Sets two rivets in one operation

Rivets deep hollow shapes automatically

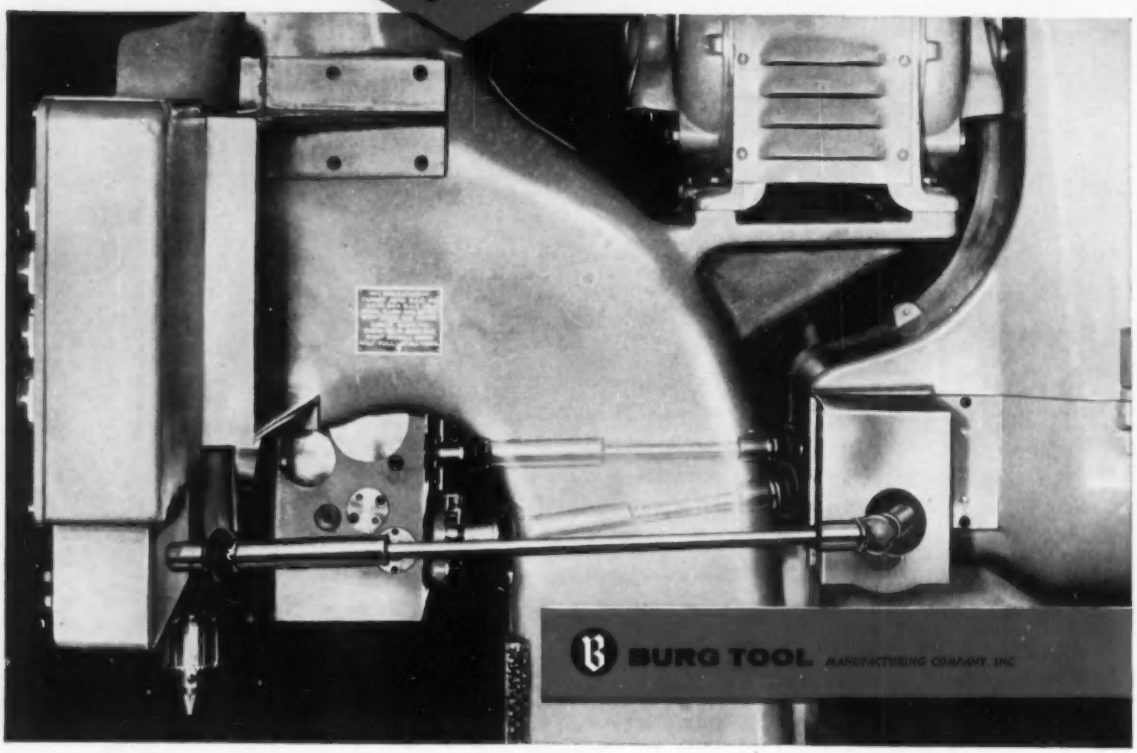
Sets heavy-duty rivets rapidly, automatically

THE MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

3 DRIVE PROBLEMS . . .

solved with 3 APEX universal joint assemblies



The spindle, indexing and speed control drives on this Burgmaster turret drill are served by Apex covered double universal joint assemblies. Each of these drives posed its own set of design problems to Burg Tool Mfg. Co. Gardena, Calif. —and all were effectively solved with Apex universal joint assemblies.

If your design problem involves universal joints or universal joint assemblies, consider these advantages, exclusively yours when you specify Apex covered industrial universal joints:

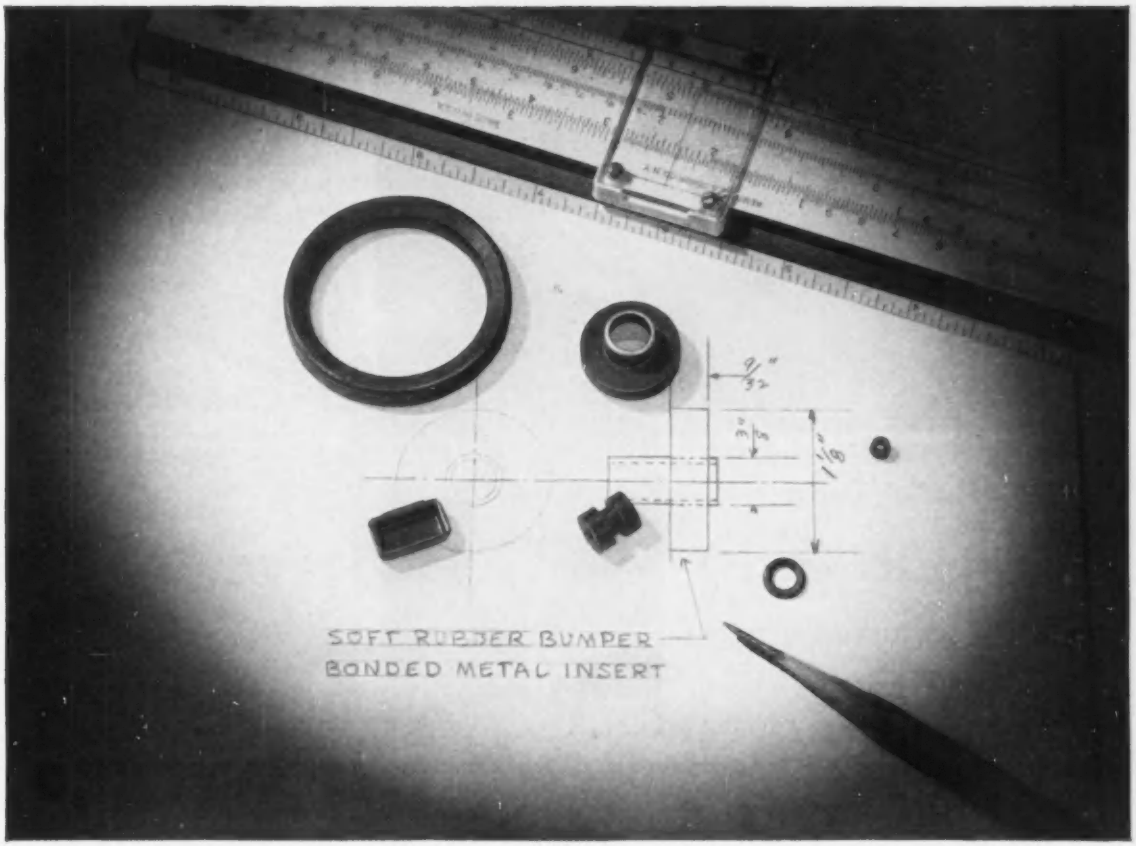
- *Clean, sustained lubrication.*
- *Efficient operation in wet or dry, corrosive or abrasive conditions, and in extremes of temperatures.*
- *High overload capacity.*
- *Low deflection rate.*
- *High strength-weight ratio per size.*
- *Long, trouble-free service life.*

You'll find complete information, and some very helpful Application Data Sheets, in our Catalog 27; write, on your company letterhead please, for your copy.

APEX

industrial universal joints—3/8" to 4" diameters

THE APEX MACHINE & TOOL COMPANY
1039 S. Patterson Blvd. • Dayton 2, Ohio



Super soft rubber answers many problems!

SEALS! CUSHIONS! ABSORBS SOUND!

Here's an exciting new material formulated and developed by ROTH Rubber... a non-porous rubber with a softness from 5 Durometer up. Applications range all the way from a tiny, sound absorbing mounting ring used in a hearing aid to bonded conveyer belts where superior gripping and cushioning qualities are required. It may be the solution to *your* problem. Check the specifications, send the coupon for a free sample... ROTH will be happy to work with you.

PHYSICAL PROPERTIES—ROTH RUBBER COMPOUND D992

PROPERTY	UNAGED	AGED 70 HOURS						
		212F Air	212F #1 Oil	212F #3 Oil	200F Water	85F Isooctane	85F Type III Fuel	85F Naphtha
Hardness	7	27	30	1	8	9	5	9
Tensile Strength	500 psi	750	600	250	200	450	400	500
Elongation	800%	550	550	750	550	750	750	800
Compression Set	50%							
Volume Change	*	*	—36%	+90%	+25%	—17%	+20%	—2%
Cold Bend	—60F OK —65F Brittle							

Dielectric Strength measured on 1/8-inch thick slab: At 10,000 volts the rubber passes 2 micro-amperes of current; at 15,000 volts the insulation breaks down. High Temperature Use—estimated limit 200F.

ROTH MOLDS AND COMPOUNDS RUBBER TO MEET ALL SPECIFICATIONS. TELL US YOUR PROBLEM. NO OBLIGATION!

ROTH
RUBBER COMPANY
1860 S. 54th Avenue, Chicago 50

Send for free sample **OF THE RUBBER THAT FEELS LIKE SKIN!**

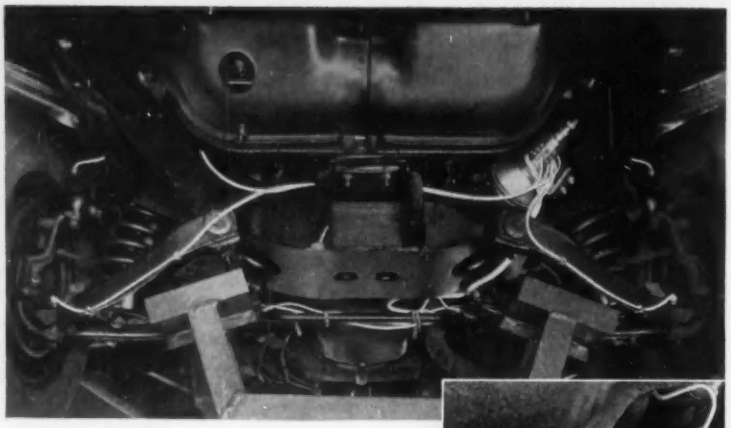
Name_____ Title_____

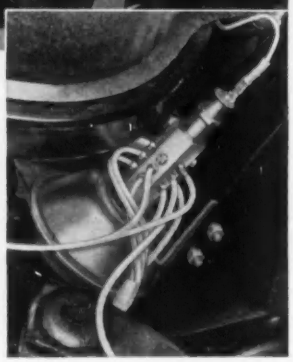
Company_____

Address_____

City_____ State_____

PE-14





Why Lubrication Engineers Specify nylaflow® Tubing To Solve Hard-Service Installation Problems

• Push-button power lubrication systems like the installation shown above depend on NYLAFLOW pressure tubing for this tough service. For flexible NYLAFLOW, produced from specially processed nylon, has the characteristics required to make these systems desirable—cost-wise and performance-wise.

ALMOST UNLIMITED FLEX LIFE—The continuous flexing and vibration of automobile front wheel suspensions causes no fatigue in highly flexible NYLAFLOW.

HIGH STRENGTH—Few tubings can approach NYLAFLOW's high strength per weight ratio. NYLAFLOW, available in burst strengths of 1000 psi. and 2500 psi., is 1/2 the weight of aluminum, 1/9th the weight of copper.

CRUSH PROOF, DENT PROOF—NYLAFLOW's bone-like structure offers high resistance to accidental shock or impact.

CORROSION RESISTANT—NYLAFLOW is impervious to hydrocarbons and practically all solvents, including hydraulic fluids, alkalis and salt spray.

LOW INSTALLATION COST—NYLAFLOW requires no pre-bending for installation—bends easily and symmetrically to exact shapes required, needs no special fittings or flexible couplings, and is easily worked from light, compact coils.

NYLAFLOW is available in a variety of sizes and coil lengths. Write today for latest test and application data.

THE POLYMER CORPORATION of Penna. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine St., W., Montreal, P.Q.

POLYPENCO® Nylon, Teflon*, Q-200.5 and K-51

*DU PONT TRADEMARK

speed of 400 steps per second, and gives 20 measurements per second. At the end of each measurement the converter provides a relay closure that triggers the recorder. Non-Linear Systems Inc., Del Mar Airport, Del Mar, Calif.

For more information—
Circle 83, inside back cover

Hermetic Plate Transformers

In addition to the primaries being tapped for 105, 115, 210, 220 v service, the secondary windings are tapped to provide either of two d-c output voltages.

Eight standard types cover the range from 365 v, dc, at 275 ma to 2550 v, dc, at 1 amp. United Transformer Co., 150 Varick St., New York 13, N. Y.

For more information—
Circle 84, inside back cover

Insulating Washers

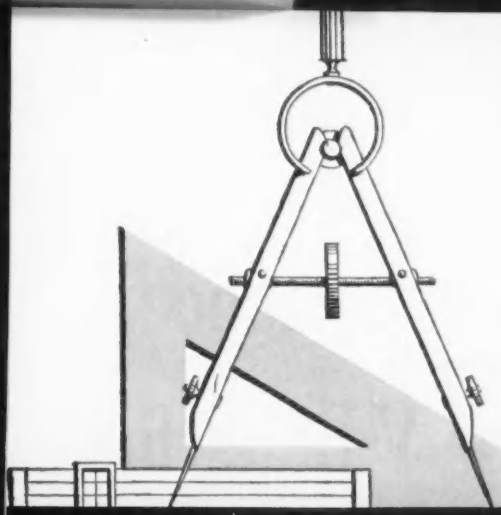
Washers and discs are stamped from plastic sheet and film at high production rates, holding tolerances of ±0.001 in. on ID and ±0.001 in. on OD. Parts as small as $\frac{3}{32}$ in. OD, $\frac{1}{16}$ in. ID and as large as 2 in. OD, $1\frac{1}{8}$ in. ID are currently being produced. Thicknesses range from 0.001 to $\frac{1}{4}$ in. In addition to Mylar film, insulators are also being stamped from film and sheet nylon, Zytel, polyethylene, Teflon, Kel-F, laminated phenolics, glass-melamine, rubber and acetate materials. Tri-Point Mfg. & Developing Co., 401 Grand St., Brooklyn, N. Y.

For more information—
Circle 85, inside back cover

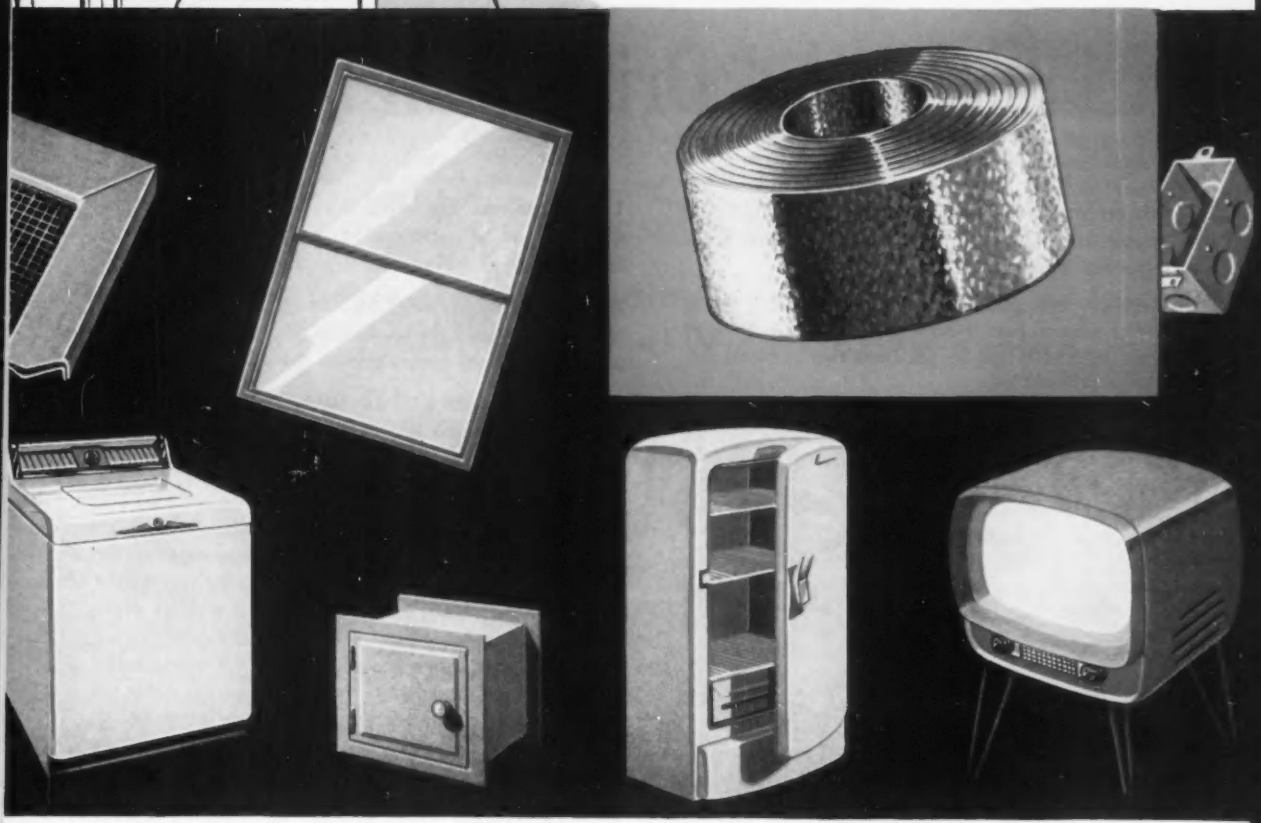
Volt-Ohm-Milliammeter

The instrument is fused to prevent most common burn-outs and instrument damage through misapplications, and it has complete meter movement overload protection. Forty-three unduplicated ranges provide a lower ratio of ranges for rapid, reliable and accurate measurements in the center of the dial. A-c current ranges (from 1.5 ma to 15 amp) eliminates the need to carry a separate meter. The

(Continued on page 310)



put these bonus advantages of WEIRKOTE galvanized steel to work for you!



For appliances, for other steel products . . . when the job calls for galvanized steel, Weirkote does that job *better.*

Weirkote is made by a special continuous galvanizing process . . . and a tight zinc coating is applied. Result: Weirkote is resistant to peeling, cracking and flaking, even under the severest stresses of fabrication. The coating stays uniform, flows evenly with the base metal, and holds fast under the deepest draws. Amazingly corrosion-resistant, too!

These are just a few of Weirkote's *bonuses* in durability, economy, customer satisfaction. Make it a point to investigate Weirkote from Weirton! Remember: *In the long run, galvanized steel . . . in the LONGER run, WEIRKOTE.*

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

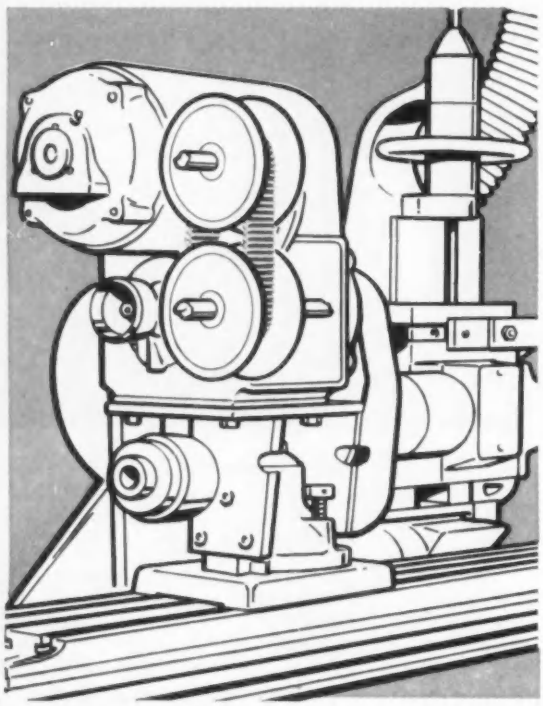
a division of

NATIONAL STEEL CORPORATION

Here's why Dayton's experience in supplying 76% of the V-Belts for Variable Speed Drives can help you

Virtually every problem present on *any* V-Belt drive must also be met in building a V-Belt to meet Variable Speed Drive specifications.

In addition, two problems must be overcome, whose difficulty of solution puts V-Belts for variable speed use on the highest level of V-Belt design. These two problems are:



For this rugged sheet metal press, Dayton Double Cog-Belts provide maximum longitudinal flexibility, extra strength and durability to take the high loads, high starting torques of the horizontal Variable Speed drive motor. Exclusive Double Cog design permits use of minimum width pulleys.

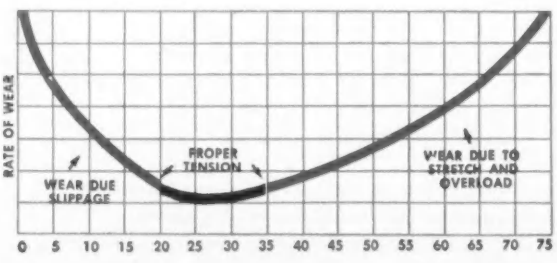
1. The need for extreme longitudinal flexibility coupled with tremendous transverse rigidity to accommodate sub-diameter pulleys and maximum axial pressures, and,

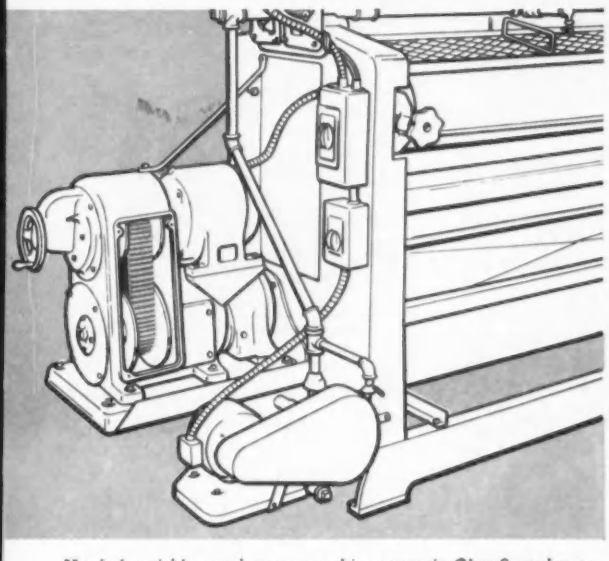
2. The need for a V-Belt of minimum width and thickness capable of meeting the requirements of a full speed range plus the ability to maintain exact speeds at each level.

The ever-increasing market for variable speed drives of higher capacities and greater speed ranges requires a continuing program of V-Belt development. One of the most successful V-Belt designs resulting from this program is the exclusive Dayton Double Cog-Belt.*

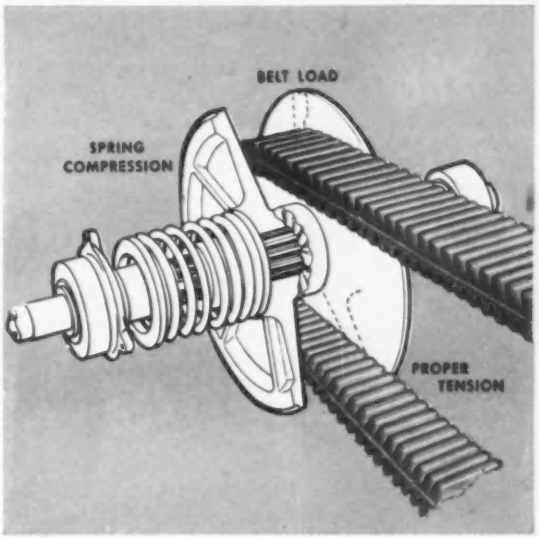
The Double Cog-Belt is the closest approach to the theoretical ultimate in V-Belt design, offering the highest pull-out torque of any V-Belt made. For its effective depth it provides a higher degree of longitudinal flexibility than any other V-Belt design and is capable at the same time of withstanding maximum axial pressures. These are among the reasons it is especially adaptable to variable speed service.

Variable speed drive manufacturers have, *through experience,* become convinced of the tremendous worth of Dayton's exclusive V-Belt designs and Dayton's skill in developing internal constructions to meet high and rigid requirements. As a result, Dayton supplies 76% of the V-Belts for the variable speed market.





Vertical variable speed motor on this automatic Glue Spreader receives full, non-slip power from Dayton Variable Speed Cog-Belts. Exclusive single Cog design offers instant speed changes, assures maintenance of constant speeds for all operations.



Tremendous crosswise rigidity is provided by Dayton Double Cog-Belts to maintain precise speed control. Greater surface area rapidly dissipates heat of flexing, prevents heat build-up. Light weight reduces centrifugal forces and internal stresses.

Dayton's experience in building special V-Belts extends into every major field of V-Belt drive design.

In agriculture, heavy duty variable speed drives are used as traction drives on self-propelled farm implements. In addition, Dayton has designed and built special V-Belts, which successfully cope with such problems as misalignment, lack of tension adjustment, sub-diameter pulleys, backside idlers and use as a clutch.

In railway, V-Belts for under car drives for lighting, heating and air conditioning, are required to meet a whole new set of conditions, among them being extremes of weather, misalignment and continuous service. Dayton developed the first V-Belt drive for caboose electrification, which involved taking power off one side of a Cog-Belt and transmitting it from the other. Exclusive design of the Dayton Cog-Belt has been found so suitable for power transmission on the auxiliary drives of Diesel locomotives that they are installed as original equipment on over 90% of all new Diesels.

In household appliances, Dayton has delved deeply into the problems of designing and producing FHP V-Belts which will give long, efficient service with almost no maintenance. High on the list of problems are lack of space for take up, sub-diameter pulleys and elimination of vibration. These problems are simple enough to solve in pilot V-Belts, but Dayton has a successful record of maintaining pilot quality in production quantities.

In industry, conditions which require special belts vary from the space and weight limitations of machine tool manufacturers, to the "full surge" loads which hit a set of V-Belts when peak power is applied instantaneously. For general industrial use Dayton produces a standard line of V-Belts which can accommodate over a *quarter million* different drive designs.

For the answer to your drive problem, whatever it is, contact the V-Belt manufacturer who supplies 76% of the toughest V-Belt drive market in the world — The Dayton Rubber Co., Ind. O.E.M. Div., Dayton 1, Ohio.

*TM

© D.R. 1956

Dayton Rubber
51 YEARS OF PROGRESS

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Industrial Sales Engineers in Atlanta, Chicago, Cleveland, Davenport, Dayton, New York, San Francisco and St. Louis.

NEW GEROTOR PUMP-MOTOR

2,000 P.S.I.
5,000 R.P.M.

The new Gerotor MB-PMB1.5 Pump-Motor opens wider horizons to the hydraulic designer. Usable as either a pump or a motor, this compact power-package delivers a combination of features previously not found in standard designs.

- 2000 P.S.I.—5000 R.P.M.
- 115% Starting Torque
- 10—1 Speed Range, at
- Constant Torque
- Reversability
- Up to 3.4 H.P.
- High Efficiency, at
- Low Operating Cost.

Consult your nearest Gerotor distributor. Free literature available . . . *write:*

Progress Through Fluid Power by—

GEROTOR

MAY CORPORATION

MANUFACTURERS OF—

1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

Hydraulic Pumps and Motors

Variable Speed Hydraulic Transmissions

PneuBin—Pneumatic Bin Evacuators

666 is doubly shielded (45 MA movement) to insure reliable performance and permanent accuracy 3 per cent dc, 4 per cent ac.

Weight is 4 lb, 4 oz. Measures 3¾ x 6⅝ x 7½ in. including leather carrying case. Phaostrom Instrument & Electronic Co., 151 Pasadena Ave., S. Pasadena, Calif.

For more information—
Circle 86, inside back cover

Subminiature Relay

Contact ratings of this six-pole, double throw unit are 2 amp, noninductive, at 29 v, dc. Vibrational characteristics of 10 G through 2000 cps. U. S. Relay Co., Los Angeles, Calif.

For more information—
Circle 87, inside back cover

Intervalometer

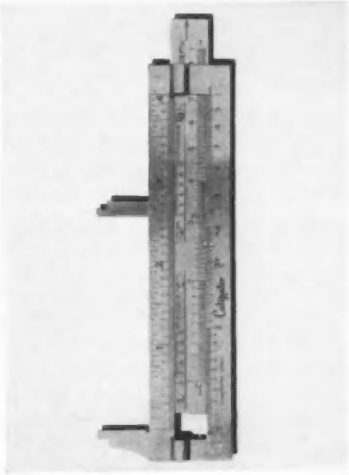
Equipped with as many as eight timing switches, this device operates at different intervals varying from 0.01 to 20 sec. The intervalometer is now being used in fire-control systems and automatic guidance systems in aircraft and other industries.

The unit has double-flange mount

(Continued on page 311)

and is $1\frac{3}{8}$ in. in diameter. According to the number of pulses required for any specific operation, the length varies from $3\frac{1}{2}$ to $4\frac{3}{4}$ in. and the weight varies from a minimum of 6 to a maximum of 8 oz. Motronics Corp., 241 Concord St., Glendale, Calif.

For more information—
Circle 88, inside back cover



Measuring and Calculating Instrument

This stainless steel instrument combines the functions of a slide rule, vernier caliper and depth gage and computer. An adjustable vernier scale allows for easy maintenance and retention of accuracy. Purple enamel is used in the precision-etched scale lines for better light reflection.

The pocket-size device measures $4\frac{3}{4}$ x $1\frac{1}{2}$ x $\frac{1}{8}$ in. thick and provides direct readings of circumferences and cross section areas. The slide rule will multiply, divide, find squares and square roots. Caliputer, P. O. Box 586, Rancho Santa Fe, Calif.

For more information—
Circle 89, inside back cover

Miniature, Flush-Type Pressure Transducer

A transducer for translating static or dynamic pressures into a linear output voltage is made of stainless steel. The flush diaphragm, which is integral with the body of the instrument, allows it to be mounted in aircraft

(Continued on page 312)

Our customer* needed a variable speed device to power a conveyor "assembly and test stand" which would accommodate metal conveyors up to 18 feet in width and up to 100 feet long. The Gerotor Variable Speed Hydraulic Transmission was the drive selected because it has a:

1. *wide enough speed range*
2. *smooth enough power flow*
3. *built-in overload protection*
4. *compact size, and*
5. *low maintenance factor.*

The installation engineered by Gerotor allows the operator to run the conveyor at speeds *from a smooth creep condition of 6 inches per minute to 120 feet per minute.* The added versatility of being able to adjust the torque output at any speed was theirs at NO EXTRA COST, and the conveyor can be stopped or reversed by means of the Gerotor Transmission.

If you have a hydraulic transmission problem . . . bring it to Gerotor. Free literature available . . . *write:*

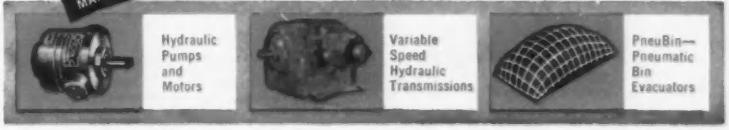
*name on request.

Progress Through Fluid Power by—

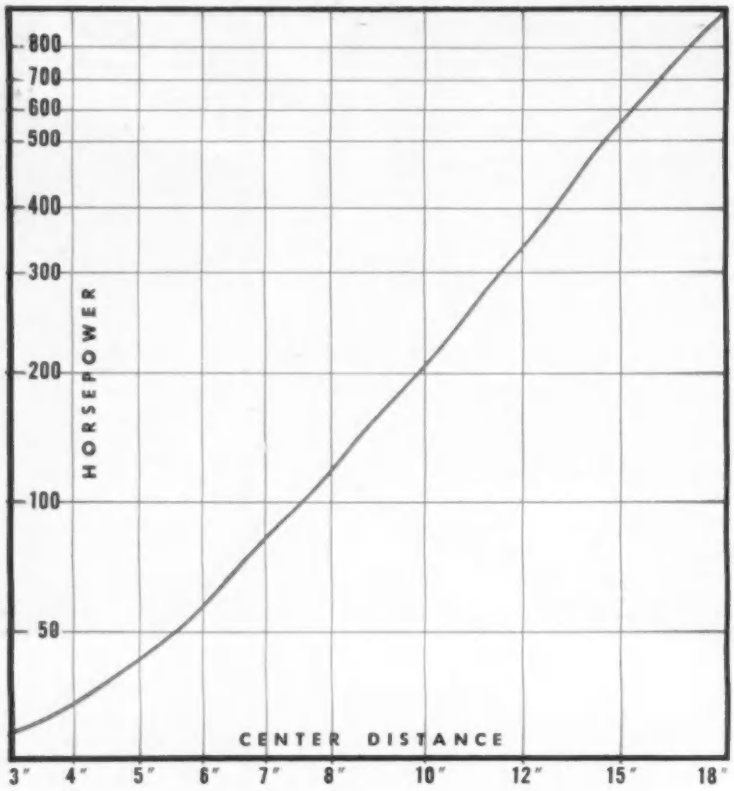
GEROTOR
MAY CORPORATION

MANUFACTURERS OF—

1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND



"DO-IT-YOURSELF"



Prove the difference in worm gear speed reducers yourself. Here's how . . .

. . . On this chart we've plotted the mechanical horsepower capacity of Cone-Drive worm gear speed reducers against their center distances. Ratings are for Class I Service with a 5:1 reduction and an input speed of 1750 rpm.

All you have to do is plot the corresponding ratings for the speed reducers you're now using or planning to use. We think you'll be surprised at the results.*

For details on Cone-Drive gearing's double-enveloping design and specifications, ask for Bulletin 600C. We'll send it to you immediately without obligation.

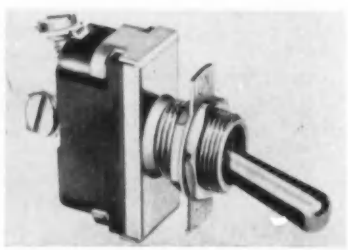
**If you're too busy to "Do-it-yourself", Cone-Drive representatives will be glad to show you filled-in charts.*

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

skins, test hulls and control surfaces, or in pressure vessels and pipes without obstructing flow or causing turbulence. Natural frequencies vary from approximately 2000 cps for the lowest range to above 10,000 cps for ranges above 300 psi.

Sensitivity for the 100 psi unit is approximately 10 millivolt per volt full scale or 1 millivolt per psi at full input of 10 v at 10 kc per sec. Frequencies ranging from 2 to 20 kc per sec may be used. Proper selection of the excitation frequency permits operation continuously at temperatures ranging up to 450 F, with little change in sensitivity. Absolute pressure ranges are from 0-15 to 0-500 psi; differential pressure ranges from ±0-15 to ±0-500 psi; gage pressure ranges are from 0-15 to 0-500 psi. Physical dimensions are 1 x 1⅛ in. long. Schaevitz Engineering, P. O. Box 505, Camden 1, N. J.

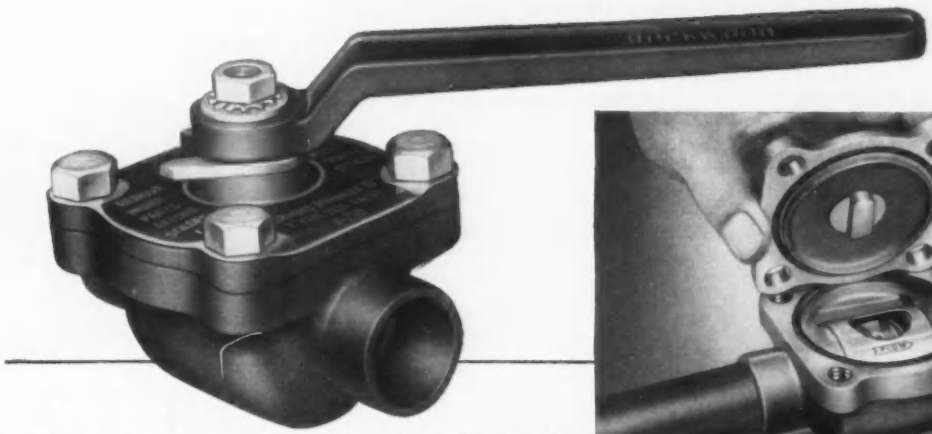
For more information—
Circle 90, inside back cover

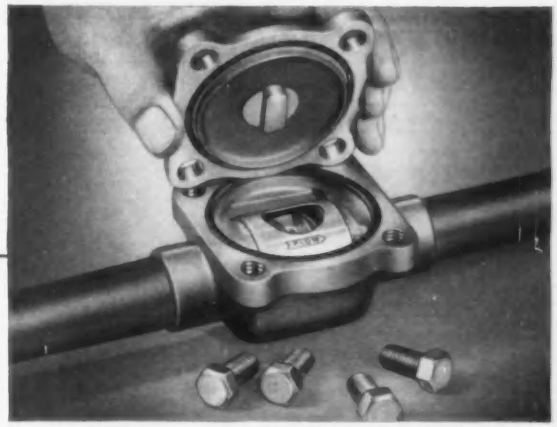


Single and Two-Circuit Switches

A line of 15 amp single and two-circuit toggle switches designed for a-c operation are available in three separate switching arrangements. Model 90 is a single-pole, single-throw

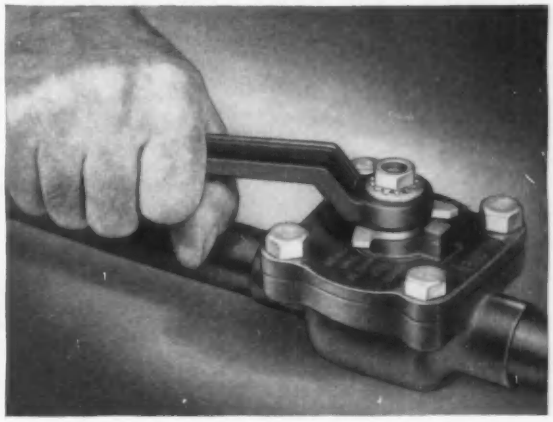
(Continued on page 314)





FAST, LOW-COST CHANGE IN DIRECTION OF FLOW. Removal of the body cap permits reversing the cage assembly to allow change in direction of flow. In addition, this feature lets you change seat material, and clean the valves thoroughly and quickly — *without removing the valve from the line!*

INTERCHANGEABILITY of seat material to meet your operating requirements is another feature of the Rockwood Top Entry Ball Valve. Seat can be furnished in Buna-N, Neoprene, Kel-F, Teflon, and Nylon.



EASY INSTALLATION AND OPERATION is permitted because of the new handle design. This new design allows the handle to be placed in any of *eight positions!*

Now!... New Rockwood Top Entry Ball Valve

. . . A new concept in valves that saves you money and time!

Made of bronze the new Rockwood Top Entry Ball Valve is ideal for handling oxygen and hazardous liquids as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas and is available both with sweat ends and screw ends, in sizes ½", ¾" and 1".

Write for complete data on this unique full round pipe size flow.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all Principal Industrial Areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
1301 Harlow Street
Worcester 5, Mass.

Please send me complete information on Rockwood Top Entry Ball Valves.

Name.....

Title.....

Company.....

City.....

Zone....State.....

- **BRUSHES** for all rotating electrical equipment (Automotive-Aviation-Industrial-Traction, etc.)
- **GRAPHITE TUBE ANODES**
- **GROUNDING RODS** for protection against rust (earth and water types)
- **NON-WELDING ELECTRICAL CONTACTS**
- **VOLTAGE REGULATOR DISCS** (carbon piles)
- **WATER HEATER and PASTEURIZATION ELECTRODES**
- **BEARINGS**
- **WELDING RODS**
- **WELDING PLATES and PASTE**
- **RESISTANCE WELDING and BRAZING TIPS**
- **MOLDS and DIES**

"EVERYTHING IN CARBON BUT DIAMONDS!"

- **SPECTROGRAPHITE**
- **POROUS CARBON**
- **SEAL RINGS**
- **FRICTION SEGMENTS**
- **TROLLEY SHOES**
- **CHEMICAL CARBON and GRAPHITE ANODES** (Plain or treated)
- **CARBON RODS FOR SALT BATH RECTIFICATION**
- **CLUTCH RINGS**
- **ELECTRIC FURNACE HEATING ELEMENTS**
- **BRAZING FURNACE BOATS and FIXTURES**
- **CONTINUOUS CASTING DIES**
- **PUMP VANES**
- **PURE CARBON** . . . and many other carbon-graphite-metal powder products

STACKPOLE

WRITE FOR DETAILS ON ANY PRODUCT

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

switch designed for on-off operation. Model 91 is a two-circuit, single-pole, double-throw switch with a center "off" position. Model 92 is a two-circuit unit similar to Model 91, except that it throws directly from one circuit to another with no "off" position.

All are rated for ¾ hp capacity and for 15 amp service at 125 v, or 10 amp at 250 v. Dimensions are: ½ x ½ x 1⅛ in. long. McGill Mfg. Co., Inc., Valparaiso, Ind.

For more information—
Circle 91, inside back cover

Voltmeter

The meter provides measurements down to 0.001 v from 0.2 to 400 mc. Two probes, a high-impedance unit and a 50-ohm type with low vswr, are provided. A full-wave crystal diode detector-circuit gives rms response in the square law region up to 0.1 v, with high readings gradually changing from rms to peak response calibrated in rms for sine waves to 3 v max. Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.

For more information—
Circle 92, inside back cover

Adjustable Power Supply

Input is regular 115 v, 60 cps line. Output voltages are adjustable, with following ranges: 2500, 5,000, 10,000, 15,000, 25,000 v. Output is filtered dc. Precise Measurements Co., 942 Kings Highway, Brooklyn 23, N. Y.

For more information—
Circle 93, inside back cover

ASCO

the one source for
RELAYS
that offers engineers complete design flexibility

The designer confronted with the specification of a relay has a genuinely unusual opportunity when he discusses his problem with an ASCO engineer. For the ASCO representative can suggest a relay for use as a unit, or as a control panel component, and meet the designer's need *exactly:*

ASCO offers both magnetically and mechanically held relays — both available with up to 12 poles normally open or normally closed — in 10 and 25 ampere sizes, AC and DC.

In addition, ASCO lists a highly diversified line of special purpose relays as *standard catalog items.*

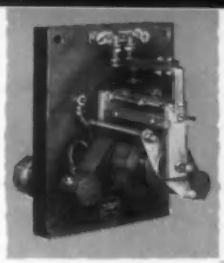
Finally, should any of these relays fail to meet specialized requirements — ASCO will design and manufacture one or more that will.

And most important —

For assured performance, ASCO Relays are current and voltage rated "make" and "break". Almost unlimited pole combinations mean fewer relays in a system — more reliable operation. Adaptability of many proven contact materials, arcing contacts, blowout coils and Class H insulating materials to ASCO Relays means suitability for all applications.

With this complete flexibility the designer can select a relay that meets his requirements, rather than have the relay limit his design.

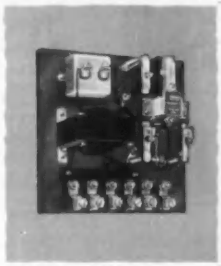
There's *one* source that solves virtually any relay problem — ASCO. Why not have the ASCO engineer call — or write outlining your relay problem. We'll be pleased to assist you.



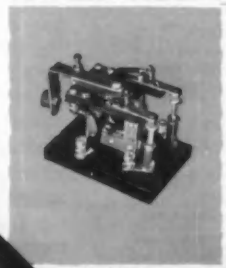
Reverse Current Relays — To disconnect DC generators from the batteries which they are charging when current flows from the batteries to the generators.

Electronic Relays — Extremely sensitive, for high speed response. "Brushing" of control leads — even momentarily — provides positive relay operation. Available, too, with time delay.

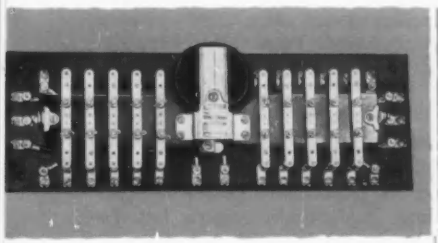
Time Delay Relays — That handle motor loads directly. Simple screwdriver adjustment makes possible delays from ½ to 6 seconds at any standard voltage. Used extensively on new brake winding motors.



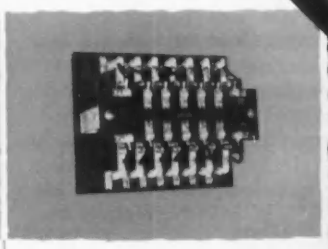
Close Differential Relays — Operate on voltage or current differential of 2% — less if required. Adjustable drop-out is standard. Adjustable pick-up is available.



Current Relays — "Coil-less" type, designed to function like a current transformer. Load cable through relay provides magnetic field for relay operation.



Many application requirements are met and surpassed with standard ASCO Magnetically Held Relays. For example, the Bulletin 1055 Relay adapts readily to such specialized control applications as control circuit transfer relays and mechanically interlocked relays for reversing motors.



This standard ASCO Mechanically Held Relay—Bulletin 1256—withstands severe shock and vibration—is used extensively for mobile units, central station control units and circuit transfer relays.

ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

385 Lakeside Avenue • Orange, New Jersey

TRADE MARK TO HALLMARK

Through the years, our trade mark has become a mark of quality that stands for the simplicity, efficiency and dependability of Curtis Universal Joints . . . the Hallmark of the industry.

In a wide range of applications, Curtis Joints offer the designer assurance of long life and trouble-free performance — because they are quality-controlled at each step of manufacture.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock
- Fewer parts, simpler construction
- Complete equipment for government tests

Our catalog torque and load ratings are substantiated by constant tests. You can depend on them.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE, SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 338.

Adhesives, Coatings, Sealers—Folder, 14 pp, lists official U. S. government specifications for a wide variety of adhesives, coatings and sealers is now available from Adhesives and Coatings Division, Minnesota Mining & Manufacturing Co., 423 Piquette Ave., Detroit 2, Michigan.

Circle 94, inside back cover

Hydraulic Cylinder Moutings—Bulletin 76, 4 pp, contains dimensional and other data on universal and trunnion types. Hanna Engineering Works, 1765 N. Elston Ave., Chicago 22, Ill.

Circle 95, inside back cover

Speed Control Valves—Bulletin 253A, 4 pp, has dimensional, capacity and other data on valves having micrometer-type graduations. Hanna Engineering Works, 1765 Elston Ave., Chicago 22, Ill.

Circle 96, inside back cover

Thumb Nuts and Screws—Bulletin, 2 pp, describes small round-head thumb nuts and thumb screws, die cast in zinc alloy. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 97, inside back cover

Fastenings—Catalog 55A, 44 pp, describes line of bolts, nuts, rivets, screws and other industrial fasteners, including illustrations, sizes, packaging information and prices. Clark Bros. Bolt Co., Milldale, Conn.

Circle 98, inside back cover

Metalworking—Booklet, 20 pp, describes production techniques, involving expanding, shrinking, rolling of metals. Includes step-by-step drawings and a typical sequence. Grotnes Machine Works, 5454 N. Wolcott Ave., Chicago 40, Ill.

Circle 99, inside back cover

Die Casting Alloys—Booklet, 23 pp, describes the requirements for a zinc-base alloy both for die casters and for designers who specify die castings. Henning Bros. & Smith, 91-127 Scott Ave., Brooklyn 37, N. Y.

Circle 100, inside back cover

O-Rings—Folder, 4 pp, describes seals manufactured from thin-walled tubing for applications involving high temperatures, acid, radio-activity, electronic or corrosive conditions. Advanced Products Co., P. O. Box 75, North Haven, Conn.

Circle 101, inside back cover

Electro-Mechanical Assembly Kits—Brochure TDS 1110, 12 pp, provides information about group of servo electro-mechanical assembly components for developmental breadboarding. Servo Corp.. of America, 20-20 Jericho Turnpike, Hyde Park, N. Y.

Circle 102, inside back cover

Panel Meters—Catalog VM-106, 4 pp, describes miniature, panel-mounting vacuum tube voltmeters. Trio Laboratories, Inc., 4025 Merrick Road, Seaford, L. I., N. Y.

Circle 103, inside back cover

Vibration Mountings—Catalog FR-55, 4 pp, describes line of vibration mountings and fan and motor bases. T. R. Finn & Co., Inc., 200 Central Ave., Hawthorne, N. Y.

Circle 104, inside back cover

Heavy Duty Clutches—Bulletin 120-D, 7 pp, describes enclosed clutches, driving spiders and rings, throw-out yokes, hand levers. Twin Disc Clutch Co., Racine, Wis.

Circle 105, inside back cover

Packings—Bulletin, 8 pp, describes split and folded types of Teflon envelope gaskets, solid gaskets and packings. Raybestos-Manhattan, Inc., Passaic, N. J.

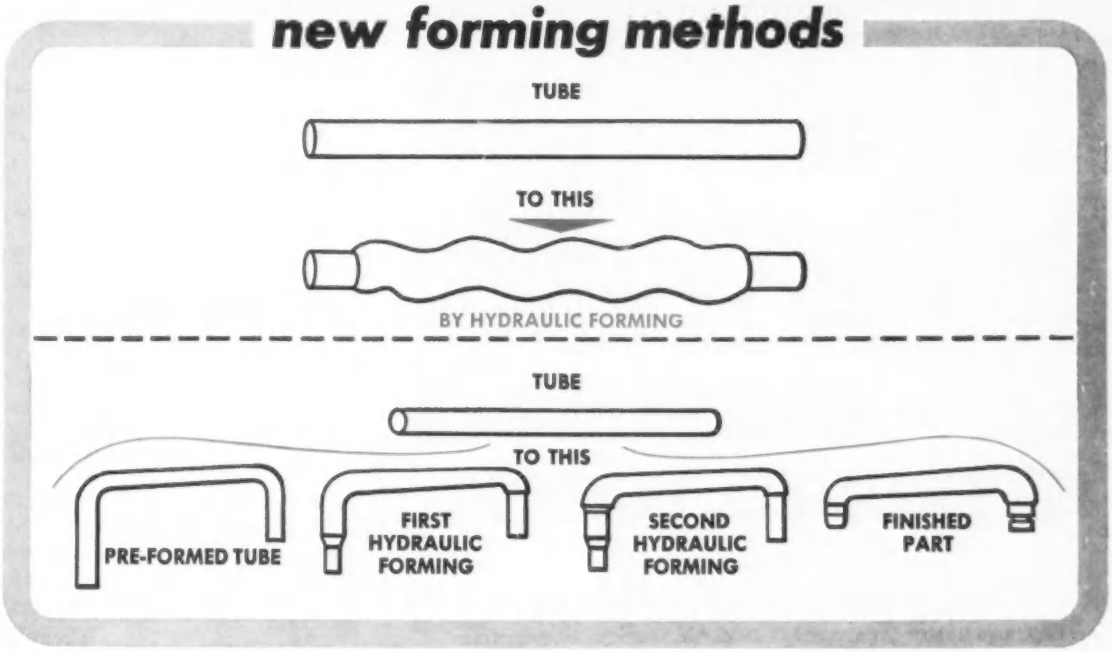
Circle 106, inside back cover

Miniature Gear Train—Brochure, 8 pp, has basic information for setting

(Continued on page 318)

IF YOU PRODUCE PARTS FROM STEEL TUBING...

it may pay you to investigate new forming methods

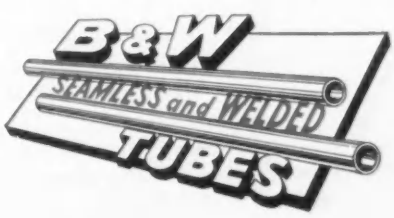


Often a single change made in your production procedures can result in a better product with savings in fabricating time and cost. And even if your current production methods are "good enough", you can't afford to overlook any improvement which might be adapted to your operation. For example, hydraulic forming is a unique, simple forming method having advantages—where applicable—which include fewer operations to produce the finished part, reduced tool costs and lower maintenance costs.

But whether you form your product hydraulically or by other methods, the original tubing you choose must be *right* . . . must have the precise combination of formability and strength required for your product. Only with the *right* tubing can you make that product to quality standards, at the lowest possible cost to yourself. And whatever your manufacturing requirements may be, B&W Mechanical Tubing can meet them. It is available in the fullest range of analyses, sizes, finishes and properties, and *one* combination of these is tubing tailor-made to your requirements.

Call for Mr. Tubes. He's your link to B&W through our Regional Sales Offices and a nationwide network of experienced tubing distributors. Get the benefit of his complete knowledge of tubing for all applications to help you match tubing to your requirements and to point out practical fabricating economies.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.— Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing



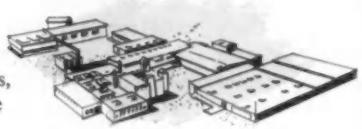
TA 4055(M)

Underwater sightseers

Depend on GERING EXTRUDED TUBING

You'll agree that a snorkel is no better than its life-line, the tube that carries the vital supply of air to the swimmer. In both their single-tube and their "Double-Header" snorkel, Globe Rubber Products of Philadelphia, use acetate tubing from Gering's Extruded Products Division for this important task.

COMPLETE PRODUCTION FACILITIES!



For the finest in lightweight, durable, easily formed plastic extrusions in a complete range of thermoplastic materials, come to Gering. At your service are hundreds of dies . . . complete custom die-making . . . and a wide range of modern extrusion equipment. Why not send us your blueprint—let us bid on your next job. Find out for yourself that Gering means top quality plus dependable delivery . . . made possible by one of the most complete and efficient extrusion plants in the world!

Gering Extrudes

Polyethylene, Acetate, Butyrate; (Tenite II), Acrylic, Vinyl, Polystyrene, Ethyl Cellulose, Copolymers

Service • Quality • Dependability

GERING PRODUCTS, INC.

KENILWORTH, N. J.

Visit Our Booth Number 944-945, National Plastics Exposition, New York Colosseum, June 11th to 15th

up company standard for gear train design. Washington Machine & Tool Works, Inc., 1001 Washington Ave. S., Minneapolis 15, Minn.

Circle 107, inside back cover

Semi-Pneumatic Wheels—Data Sheet 401, 4 pp, contains specifications and design engineering data for puncture proof, steel disc wheels. Gleason Corp., 250 N. 12 St., Milwaukee 3, Wis.

Circle 108, inside back cover

Automatic Transfer Switches—Publication 596, 16 pp, describes electromagnetic devices designed to transfer load from normal to emergency power source. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle 109, inside back cover

Wound Cores—Bulletin WC-356, 32 pp, includes mechanical dimensions, tolerances, weights, along with curves giving exciting runs va per lb and watts per pound and the a-c magnetization with various d-c bias. Tohmas & Skinner, Inc., 1178 E. 23 St., Indianapolis, Ind.

Circle 110, inside back cover

Precision Components—Bulletin G-3, 4 pp, contains specifications for encapsulated precision wire-wound resistors, encapsulated toroid coils, miniature magnetic clutches, precision wave filters, telemetering filters, precision ratio transformers, miniature toroid power transformers, magnetic amplifiers, decade inductor units, program equalizers, variable filters and variable attenuators. Hycor, 12970 Bradley Ave., Sylmar, Calif.

Circle 111, inside back cover

Springs—Catalog 5, 47 pp, contains design formulas, metal properties, application data for helical and wire springs, pressed steel parts, castings, stampings. Union Spring & Mfg. Co., New Kensington, Pa.

Circle 112, inside back cover

Hydraulic Cylinders and Valves—Bulletin 22, 36 pp, has information on 1000 and 2000 psi cylinders and directional control valves. Pathon Mfg. Co., Pacific Ave., Cincinnati 12, Ohio

Circle 113, inside back cover

Metal Alloys—Bulletin 7, 8 pp, presents case history and availability data

(Continued on page 323)

Long awaited...

On the next two pages appears an announcement of a new plastic—a molding material with a unique combination of properties that answers a long-felt need of industry.

You may be among those who have long wished that such a material existed. Or you may be stimulated by this remarkable new material to think along entirely new lines.

Now, here it is...

CYANAMID

C
Y
M

AC*

Methyl – Styrene Molding Compounds

*Trademark

Announcing New Thermoplastic Molding Compounds...CYMAC

—based on Methylstyrene Monomer

NOW AVAILABLE—two compounds so heat resistant that products molded from them show no distortion after repeated, extended immersion in boiling water.

1. CYMAC 400 Polymethylstyrene—offers unusual heat resistance *plus* all the desirable properties of polystyrene, including excellent electrical properties, clarity, luster, and unlimited range of transparent and opaque colors.

2. CYMAC 201 Methylstyrene-Acrylonitrile Copolymer—offers better toughness, chemical and craze resistance than CYMAC 400—*plus* heat resistance, clarity, luster, and wide color range.

Both of these new molding compounds provide the added value of remarkable heat resistance at costs no greater than competitive materials.

These new methylstyrene thermoplastics are made possible by revolutionary new processes developed by Cyanamid. They will help you upgrade existing molded products, and find new applications in consumer and industrial fields.

Turn opportunity into reality NOW. Write or call today for complete information and samples.

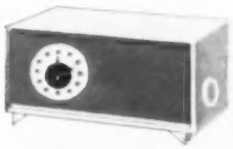
CYANAMID

AMERICAN CYANAMID COMPANY

PLASTICS AND RESINS DIVISION 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

For automotive parts

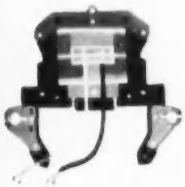


For radio cabinets

For refrigerator parts

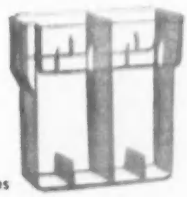
For business machine housings and parts

For pen barrels



For electrical parts

For fan blades



For battery cases

For wall tiles

. . . and hundreds of other products

CYMAC thermoplastics will be featured in Cyanamid's exhibit at the 7th National Plastics Exposition, June 11-15, which will be held in the New York City Coliseum.

SKF® Has Them All

If you want to be *sure* you are putting the right bearing in the right place in your product, check with SKF—the *one* bearing manufacturer selling all four major types of anti-friction bearings. From this single source, you quickly and easily get unbiased advice based on the broadest experience in the anti-friction field. **SKF INDUSTRIES, INC.**, PHILADELPHIA 32, PA.

7710

SKF

Ball Bearings Cylindrical Roller Bearings
Spherical Roller Bearings Tyson Tapered Roller Bearings

on thin-gage beryllium copper, phosphor bronze, nickel silver, chromium copper, stainless 17-7PH, invar and magnetic strip down to 0.0005 in. thick. Includes tables on mechanical and physical properties as well as tolerances and applicable specifications. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

Circle 114, inside back cover

Piloted-Operated Valves—Bulletin SK-356, 6 pp, describes operation, uses, optional features of single and double solenoid valves. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

Circle 115, inside back cover

Power Solenoids—Bulletin GEA-6215-A, 16 pp, gives application and accessory information on industrial solenoids. General Electric Co., Schenectady 5, N. Y.

Circle 116, inside back cover

Manual Motor Starters—Bulletin GEA-6358, 8 pp, gives application information on straters for fhp and integral horsepower motors to 7½ hp. General Electric Co., Schenectady 5, N. Y.

Circle 117, inside back cover

D-c Amplifiers—Data Sheet 80-1, 4 pp, contains descriptions and schematic drawings of four typical applications of the instrument, as well as general technical information concerning voltage and current amplification. Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4 St., Philadelphia 33, Pa.

Circle 118, inside back cover

One-Shot Lubricators—Bulletin 3C, 4 pp, describes three basic models, with diagrams showing dimensions, reservoir capacities and discharge volumes. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

Circle 119, inside back cover

Capacitors—Bulletins (4), 2 pp each, give information concerning construction, temperature curves, specifications and specific ordering data. Glenco Corp., Metuchen, N. J.

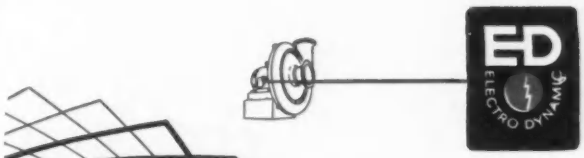
Circle 120, inside back cover

Beryllium Copper Components—Catalog, 8 pp, gives dimensions, tolerances, and specifications. Technical data

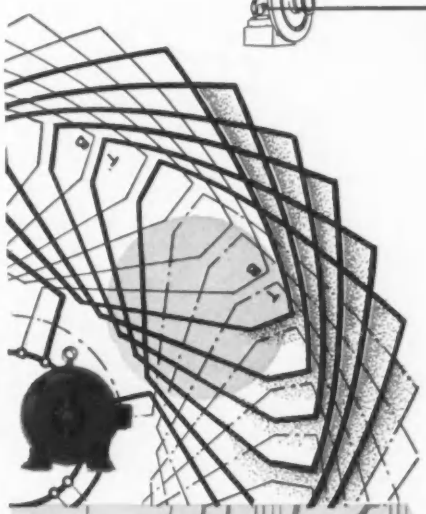
(Continued on page 327)

a better kind of power

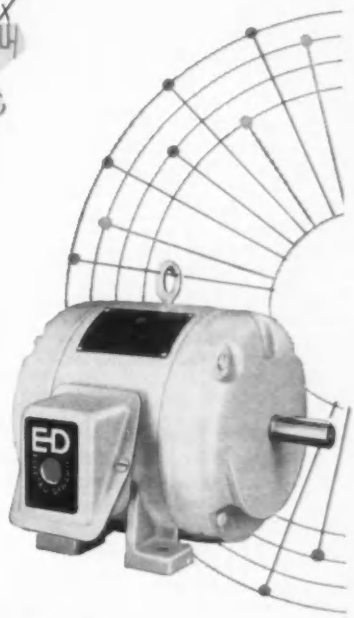
FOR INDUSTRIAL MACHINES



The mark of an Extra Dependable machine



From America's foremost producer of custom designed motors come these premium-built, *extra dependable* E.D. "power packages "for general industrial use—75 years in the making—yours today *at no extra cost!*



1 to 250 hp. AC and DC. N.E.M.A. standards.

ELECTRO Extra DYNAMIC dependable motors

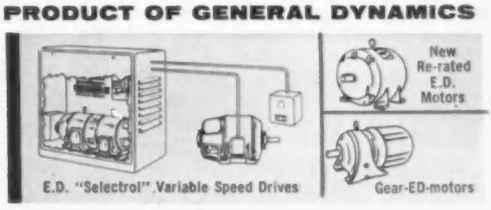
GD

PRODUCT OF GENERAL DYNAMICS

NEW...

Write for Brochure 100 and literature on new E.D. motors and drives.

Electro Dynamic division of General Dynamics Corporation Bayonne, New Jersey



RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

What's the right torque for bolts?

This is one of the toughest questions we're asked. Too many variable conditions. But the following may help.

The bolt takes two stresses during wrenching: (1) Torsion, (2) Tension. Tension is what you want. Torsion is the necessary evil due to friction. Probably 90% of applied torque goes to overcome friction.

With the friction factor changed by lubrication, plating, etc., the torque needed to produce a given tension is hard to predict. However, a useful empirical formula exists for *normal* friction conditions.

Inch-lbs. Torque = 0.2 x bolt diameter x bolt tension

Many tests show that the 0.2 torque coefficient is approximately constant for the usual friction conditions, for all diameters, and for both coarse and fine thread. Average deviation is about 7%. But when are conditions *"normal"?* The only *sure* way to check torque is to set up a pilot assembly and try it out.

In pilot testing for rigid joints, tighten a few bolts with torque wrench to failure, and then set torque at 75% of that load; or even at yield strength, since torsion component vanishes leaving bolt under tension only, which is well below ultimate strength.

We've worked up curves giving suggested torques for various size bolts. Send for a copy.

How to make a stronger joint

From research on structural steel joined with high strength bolts come facts applicable to *products:*

These bolts can be torqued to high tension for a large clamping force on joined members. Resultant friction overcomes shearing forces and prevents slippage. The higher compressive forces also protect bolt holes from fatigue cracks. Moreover, the tighter the bolt, the less chance for loosening, and the less risk of bolt fatigue due to dynamic loading.

High strength bolts are stronger in shear, too. In recent tests, rivets and "soft" bolts broke under extreme shear load; but high strength bolts didn't—the joined steel failed first.

APPLYING THE ADVANTAGES

Since high strength bolts have 2 to 3 times more tightening strength than common bolts, smaller diameter bolts can be used. As discussed above, these make a stronger joint; also weigh and cost less.

Along with good joint design, it's important that fasteners used can meet requirements. For example: A manufacturer designed vibrating machinery for high tensile bolts, but it was assembled with low carbon bolts. Joints failed. RB&W high carbon bolts with hardened washers solved the problem.

Moral: *Specify* even your standard fasteners.

RB&W selects the proper grade of steel to give "Empire" high strength fasteners the precise balance between *tensile strength* and *ductility.*

Feel free to call on RB&W for help in selection and use of standard, low cost fasteners.

Three radial dashes on bolt head denote a high strength bolt. The "E" identifies Empire bolts, an RB&W trademark. These markings assure highest quality standard fasteners with full strength, and uniformity of size and physicals.

●

Russell, Burdsall & Ward Bolt and Nut Company . . . plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Silicon bronze fasteners combine desirable features

Silicon bronze offers the highest conductivity of fasteners able to withstand high stresses. It resists corrosion, stays free from season cracking, too. It makes ideal fasteners for electrical use where tensile strength is important; or for corrosive environments.

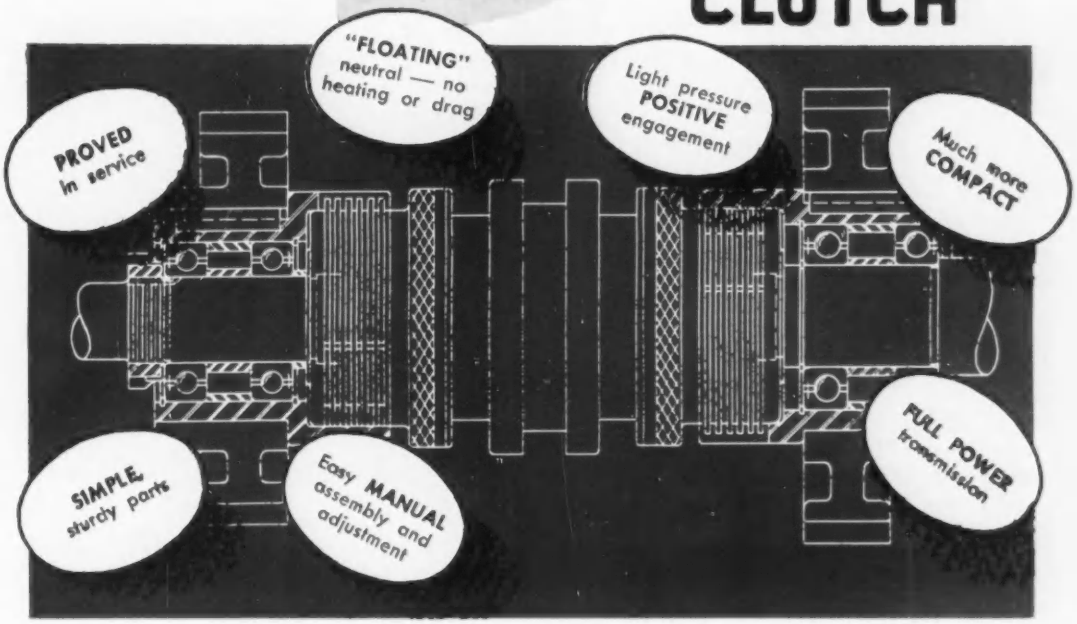
One of the first to develop such fasteners, RB&W cold works them for tensile strength and for clean, well formed threads that don't seize. Oval bolts, hex bolts and nuts and U bolts available. Specials can be developed.

BUILD INTO YOUR PRODUCT THE TROUBLE-FREE PERFORMANCE OF A

MAXITORQ

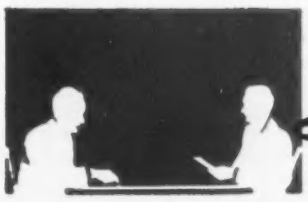
floating disc

CLUTCH


"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
PROVED in service
Much more COMPACT
FULL POWER transmission
Easy MANUAL assembly and adjustment
SIMPLE, sturdy parts

Here is an example of the simple, rugged, and compact installation possible with a MAXITORQ Double Clutch, with pulley-type driving cups, as the speed-change control between high and low-speed gears. Since MAXITORQ clutches, because of their exclusive design features, are always quick and positive in action while at the same time completely free in neutral, this type of installation has a well-proved record of performance to recommend it.

Other types of MAXITORQ Floating Disc Clutches . . . single, double, and overload release . . . are available in a wide range of stock sizes to meet the needs of a great many installations. Our engineering department also stands ready to help you with special drive problems. Write or phone Dept. PE-6. The Carlyle Johnson Machine Company, Manchester, Conn.



Let's talk **MAXITORQ**

EATON

DYNAMATIC®

SINGLE PACKAGE FRACTIONAL HP AJUSTO-SPEDE® DRIVES

Provide Stepless Adjustable Speed from an AC Power Source

Sizes and Types for Hundreds of Industrial Applications

Dynamatic Ajusto-Spede® Drives, part of a family of diversified eddy-current equipment, provide an economical solution to many adjustable speed drive problems.

The Fractional Horsepower Ajusto-Spede, a single package design, combines an AC constant speed induction motor, eddy-current coupling, and electronic control. Standard modifications provide for the addition of electrically operated fail safe friction brakes, or speed reducers with numerous gear reduction ratios.

Fractional Horsepower Ajusto-Spede Drive power is taken directly from 115/220 volt, single phase or 220/440 volt, 3 phase lines. Sizes are ¼, ⅓, ½ and ¾ horsepower at 1600 RPM; ½, ¾ and 1 horsepower at 3200 RPM.

Friction brakes for quick stopping or fast cycling operation are furnished in two capacities—1½ and 3 pounds feet of torque.

Gear reductions with 10 ratios between 5-to-1 and 100-to-1 are supplied with 1600 RPM Ajusto-Spedes.

Ajusto-Spede® Advantages

- ★ **Constant torque speed range: 25 to 1 with either 1600 RPM or 3200 RPM Ajusto-Spedes.**
- ★ **Control accuracy: 2 per cent of top speed at any point within the speed range.**
- ★ **Minimum wiring to power line.**
- ★ **Remote "one knob" control operation up to 100 feet.**
- ★ **Rugged plug-in type integral one-tube electronic control.**
- ★ **Permanently sealed grease-packed bearings.**

For more detailed information, write for your free copy of the Dynamatic Fractional Horsepower Ajusto-Spede Bulletin, FAS-5.

EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

KRAISSL

■ Since 1926 ● in the application, design and mfg. pumps — separators — hydraulic accessories.

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary Oil Pumps

•

Vacuum Powered Transmission and Low Pressure Air Service

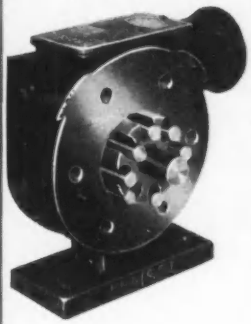
•

Air and Liquid Filters

•

What's your problem?

- √ higher pumping speeds?
- √ tolerance of particle-laden liquids?
- √ peak suction for primary pumps?



the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller - rotor design easily handles particles that would jam more tightly - fitted mechanisms — reduces cavitation, allowing higher speed operation* — develops high suction characteristics.

** Roller mechanisms permit higher speeds with any oil than most displacement designs.*

KRAISSL KRAISSL CO Inc

289 Williams Ave., Hackensack, N. J.

Catalogs and Bulletins . . . . . continued

about custom-made stampings is also included, together with handy tables, charts, and line drawings. H. Braun Tool & Instrument Co., Inc., 140 5 Ave., Hawthorne, N. J.

Circle 121, inside back cover

Plastic Structural Materials, Moldings, Weldments—Catalog, 7 pp, contains information on polyethylene and polyvinyl chloride. Specifications are given in chart form for ease of reference. American Agile Corp., P. O. Box 168, Bedford, Ohio.

Circle 122, inside back cover

Reading Glasses and Magnifiers—Folder, 6 pp, describes magnifying equipment. Apex Optical Corp., 50 Valley St., Providence, R. I.

Circle 123, inside back cover

Automatic Temperature Control—Catalog D-31, 19 pp, describes differential transducer control and automation systems, a line of time control equipment including electronic, equipment operator mechanisms, valves, counters and electronic contactors. Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa.

Circle 124, inside back cover

Roller Bearings—Catalog 55, 72 pp, contains specification and data pages on shaft sizes from ¾ to 7 in., including rating tables, exploded view for parts identification. Chain Belt Co., Milwaukee 1, Wis.

Circle 125, inside back cover

Ball Bearings—Catalog AFB-1, 32 pp. Dimensions and load ratings are given for single row, double row, deep groove radial, and angular contact bearings. Industrial Tectonics, Inc., 3684 Jackson Road, Ann Arbor, Mich.

Circle 126, inside back cover

Wire Rope—Bulletin DH-128D, 24 pp, covers more than 120 different types of wire ropes. American Chain & Cable Co., Inc., Wilkes-Barre, Pa.

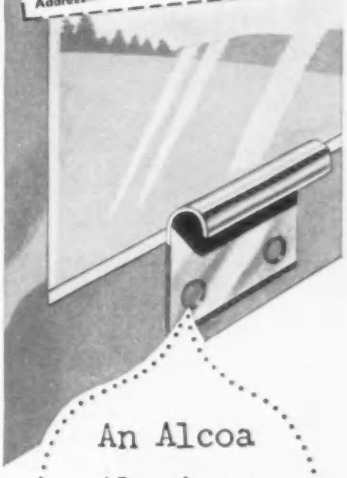
Circle 127, inside back cover

Power Supplies—Data file provides ratings on over 500 stock-model supplies, in addition to a discussion of methods of rating power supply performance, including output range, regulation, ripple, internal impedance,

(Continued on page 330)

FILL OUT COUPON FOR FACTS, SAMPLES

ALUMINUM COMPANY OF AMERICA
2247-F Alcoa Bldg., Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.
Name
Title
Company
Address



An Alcoa Aluminum Fastener should be used here!

It's an aluminum window lift assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P. S. In this window lift assembly, we suggest an aluminum 78° countersunk rivet. One of Alcoa's complete line of aluminum fasteners.

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

YOUR GUIDE TO THE BEST IN ALUMINUM VALUE

ALCOA ALUMINUM

Now...shakers for random motion vibration testing

Three new high performers which are particularly adapted to random motion vibration testing join the unique line of MB Vibration Exciters. With them, virtually every modern test requirement for sinusoidal or random motion can be met with increased data-reliability.

Model C6 extends testing range to 5000 cps without axial resonance . . . has a moving element weighing only 3½ pounds . . . delivers 200 pounds of force.

Model C10 develops 1200 pounds force . . . and up to 67.5 "g". Usable to 3000 cps, it has a suspension system that assures true rectilinear motion, with first resonance of unloaded 17½-pound moving element over 3000 cps.

Model C25H rated at 3500 pounds force, now has a newly designed moving table assembly weighing only 75 pounds . . . yet the axial resonance remains well above operating limit of 2000 cps.

These shakers put into practice the advanced vibration engineering for which MB's specialists are known, and which is always ready to assist you.

GOOD VIBRATION EXCITER INSURANCE

Remember, MB maintains a service department second to none in *scope* of service and size. It does installation checkouts, instructs operating personnel, and "trouble-shoots". Such service assures that you'll get the most from your equipment.

Ask for recommendations on your specific needs, or look over the MB line by sending for Bulletin 420-B-6

MB manufacturing company
A division of Textron American, Inc.
1060 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO CONTROL VIBRATION . . . TO EXCITE IT . . . TO MEASURE IT.

high-strength • corrosion and wear resistance • lasting good looks

These *Band-It* clamps, for example, are used for hundreds of industrial uses – indoor and out. They have to be strong . . . often must last for years in highly corrosive atmospheres. Good reasons why Crucible type 301 *stainless steel* is used in their manufacture.

For fittings like these, large heat exchangers, process vessels, or many other applications, *stainless has advantages* no other metal can provide. Among them are high creep and fatigue strength . . . heat resistance . . . sparkling, life-time beauty . . . and excellent workability.

Let a Crucible representative help you make the best, most profitable use of stainless. And, when you decide on the *right* type for your job, you'll find it promptly available from nearby Crucible stocks. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

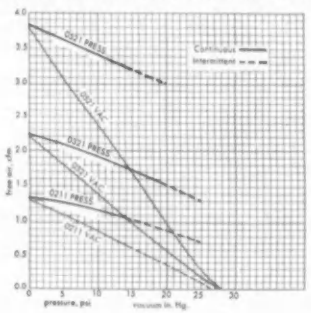
Get 10 Integral-Motor-Pump advantages in two NEW types (three models) of

GAST rotary vane AIR PUMPS

Designers seeking a dependable vacuum or pressure source for industrial instruments, vending machines, air gauge circuits, air sampling, laboratory equipment, printing and packaging machinery, etc., will find these *new* Gast Integral-Motor Air Pumps highly advantageous, especially where compactness and portability count. Consider these outstanding features:

1. Latest type G.E. "Form G" motors.
2. More compact than any pump of equal capacity.
3. Total weight reduced ⅓—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.

Performance-Vacuum & Pressure



Write for new Bulletins V-356 and P-356!
GAST MANUFACTURING CORP.,
P. O. Box 117-V Benton Harbor, Mich.

*0321 similar in appearance.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

stability and dynamic response. NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.

Circle 128, inside back cover

Glass Pipe and Fittings—Catalog 80-10, 4 pp, describes equipment designed for laboratory or pilot plant use and other special services. Fischer & Porter Co., 683 Jacksonville Road, Hatboro, Pa.

Circle 129, inside back cover

Chromium Stainless—Booklet, 16 pp, describes price advantage, physical properties and analysis, relative corrosion resistance, fabrication, application and care of Type 430 nickel-free stainless sheet. Washington Steel Corp., Washington, Pa.

Circle 130, inside back cover

Colloidal Dispersions—Booklet, 4 pp, lists 41 colloidal and semi-colloidal dispersions for operational functions, maintenance, lubrication, machine design, and other industrial applications. Acheson Colloids Co., Port Huron, Mich.

Circle 131, inside back cover

Pneumatic Disconnect—Specification sheet, 2 pp, gives information concerning construction and applications of this disconnect. Converts any pneumatic connection into a straight-through line with pressure drop equivalent to that of a straight, smooth tubing section. Eastern Aircraft Products Corp., 229 Riber St., Orange, N. J.

Circle 132, inside back cover

Liquid Springs—Catalog LS, 2 pp, describes and illustrates line of liquid springs designed for replacing coil springs in die applications using liquid compressibility. Taylor Devices, Inc., 188 Main St., N. Tonowanda, N. Y.

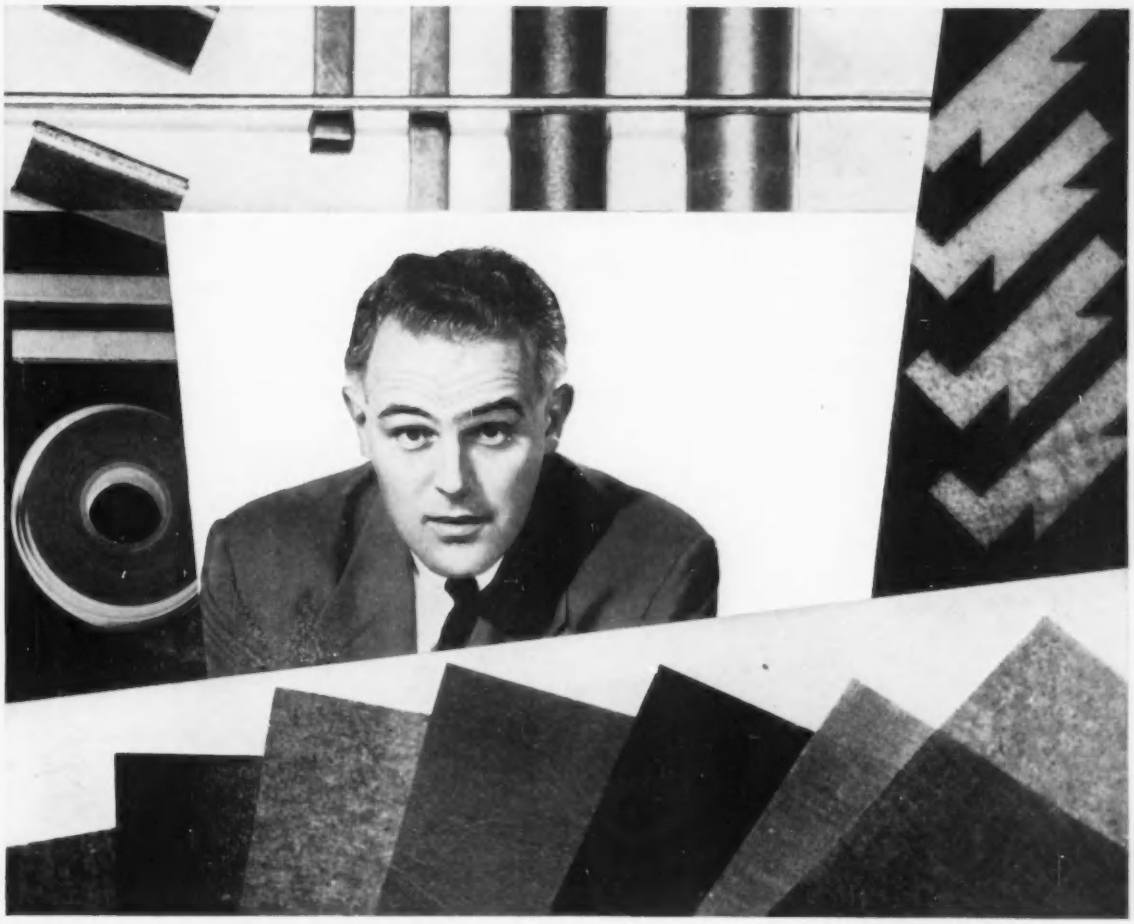
Circle 133, inside back cover

Pipe and Tubing—Data card TDC-163A, 6 pp, furnishes information on analysis, mechanical and physical properties and creep and rupture data on many tubing alloys for elevated temperature service. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 134, inside back cover

Fhp Motors—Catalog RB-400, 12 pp, contains information on electric

(Continued on page 334)



ARE YOU FAMILIAR WITH...

epoxy-bonded
silicone-bonded
capacitor grade

ISOMICA®

...and all the many applications and benefits of these versatile electrical insulating materials?

Enormous strides have been made in micaceous electrical insulation during the past few years—and MICO has been the leader in these developments.

ISOMICA micaceous materials are 100% pure mica, processed in continuous form, coated with newly developed binders, laminated and cured. The result is an entire *system* of electrical insulating materials which offers many advantages. For example:

- *more precise tolerances*
- *fewer line rejects*
- *faster, easier production handling*
- *production savings*
- *improved performance*
- *improved design possibilities*

...and many special advantages in stacked and rolled capacitors, electrical machinery and equipment of many different types.

Mail This Coupon NOW for Complete Information on ISOMICA →

MICA INSULATOR COMPANY
761 Broadway, Schenectady 1, New York
A Subsidiary of Minnesota Mining and Manufacturing Company

MICA INSULATOR COMPANY
Department 761, Schenectady, New York

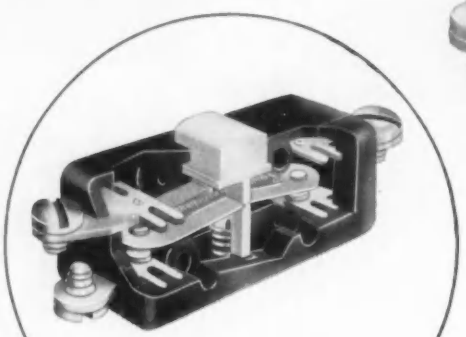
Please send me a free copy of "What Every User of Electrical Insulation Should Know About ISOMICA."

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

NOW!

extremely long life in a precision

Snap Action SWITCH



Rated 10 amps. 30 V.D.C.
Und. Lab. Approved
125 or 250 V.A.C.

1. **Excellent shock resistance: 10 G's to 2,000 cycles/sec. shock 50 G's 11 ms.**
2. **Rugged, Ammonia-free Plastic Case with Double-ended Bearing**
3. **Molded, Self-lubricating Nylon Button**
4. **Labyrinth Dust Seal for Spring Mechanism Protection**
5. **Two Circuit, Double-break Contacts**
6. **Stainless Steel Operating Spring**

NEW! HERMETIC LIMIT SWITCH
LICON TYPE 60 switch featuring the exclusive "WOBELLOW"* seal for true hermetic sealing. Write for information.

TWENTY MILLION SNAP-ACTIONS— YET NO BIGGER THAN A PAPER CLIP!

LICON*

TYPE 11 SWITCH

a development of Illinois Tool Works

This new Licon precision snap-action switch design eliminates dead break and provides much greater overload capacity. Constructed to military, government and industrial standards, it can be obtained in a wide movement differential range from .008 to .030. Licon Type 11 is the most compact, rugged long-life snap-action switch available. Meets MIL S-6743 specifications.

Write for LICON bulletin

ILLINOIS TOOL WORKS

Metal Cutting Tools, Gear Finishing and Measuring Machines and SHAKEPROOF® Fastenings

LICON

SWITCH AND CONTROL DIVISION

2501 N. Keeler Avenue Chicago 39, Illinois

BASIC SWITCHES • MINIATURE SWITCHES • DIE CAST ENCLOSED SWITCHES
AIRCRAFT and INDUSTRIAL HERMETICALLY SEALED SWITCHES

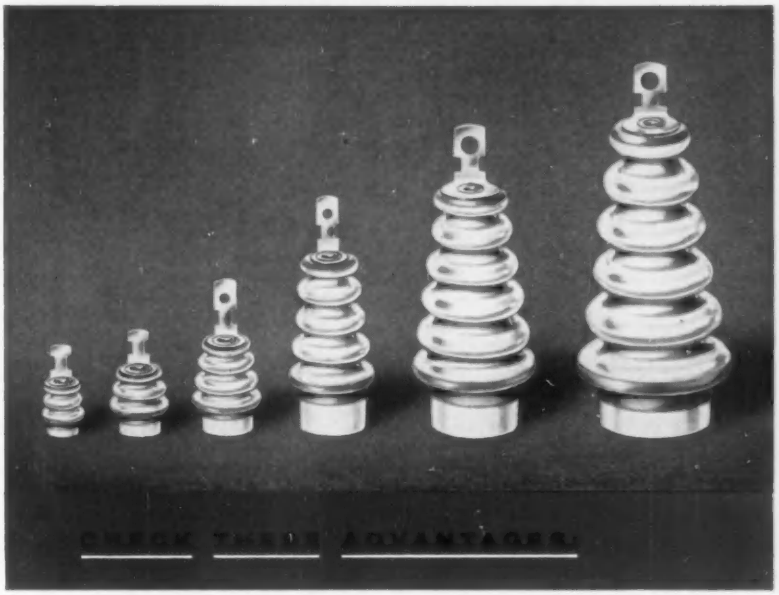
*Trade-mark

now...

Frenchtown NICOTE Metallized Terminals!

● After years of extensive research into hermetic seal problems in the electronics and electrical fields, Frenchtown proudly presents this *improved line* of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors and heater units.

Custom-engineered of HIGH ALUMINA CERAMICS and metallized with Frenchtown's exclusive NICOTE. These terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application.



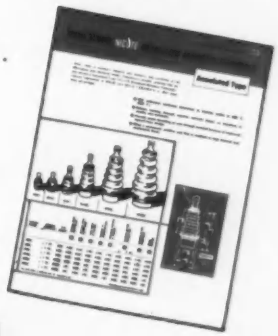
- **Will withstand *continuous* immersion in lead-tin solder at 260°C. (500°F.).**
- **Reduce tracking through superior external shape, so important in smaller size terminals.**
- **Provide easier threading of wire through terminal because of improved *tapered* bore design.**
- **Effect a permanent, positive seal that is resistant to high thermal and mechanical shock.**

FOR ENGINEERING ASSISTANCE . . .

Our national representative for Frenchtown NICOTE Metallized Terminals is: Lundey Associates, 694 Main Street, Waltham 54, Massachusetts.

FOR COMPLETE INFORMATION . . .

. . . send for Engineering Data Sheet 1055 which provides specifications for the complete line of Frenchtown NICOTE Metallized Hermetic Terminals . . . plus engineering details on a wide selection of terminal hardware.



frenchtown PORCELAIN COMPANY

87 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

AT NO EXTRA COST!

Only Grip-Master® SPROCKETS HAVE HARDENED TEETH to 7" in diameter ★

★ **YOU CUT OPERATING COSTS!**
Because hardened teeth means better resistance to shock loads and abrasion, you get longer chain drive life "on-the-shaft."

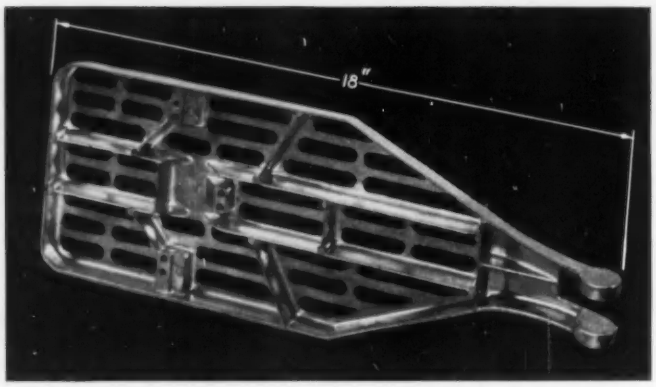
★ **YOU SAVE MAINTENANCE COSTS!**
Sprocket replacement costs are reduced about 30%. Hubs or bushings can be used over and over, with installation and removal fast, clean and simple.

★ **YOU SOLVE DELIVERY PROBLEMS!**
Grip-Master Sprockets are available "off the shelf" for quick delivery. Cuts space and storage costs for you.

For complete details, *write today* for your Grip-Master Sprocket brochure.

cullman
POWER TRANSMISSION ROLLER CHAINS AND SPROCKETS

CULLMAN WHEEL CO. • 1334 Altgeld Street • Chicago 14, Illinois



Thin walled, light weight, 1¼ lb aluminum die casting with minimum ribbing has strength safety for this gun seat used by the armed forces

Federal
DIE CASTING COMPANY
2228 NO. ELSTON AVE. CHICAGO, 14, ILL.
Phone ARmitage 6-4803

motors, blowers and special products. Redmound Co., Inc., Owosso, Mich.
Circle 135, inside back cover

Cold-Extruded Fastenings—Folder, 4 pp, describes upsetting of metal for the head of a cap screw at the same time as the shank diameter is extruded down to an accurate pitch diameter for the rolling of threads. Cleveland Cap Screw Co., 2917 E. 79 St., Box 545, Cleveland 4, Ohio
Circle 136, inside back cover

Small-Mesh Expanded Metal—Folder, 4 pp, gives weights and dimensions for various gauges and strands available, both standard and flattened. Penn Metal Co., Inc., 205 E. 42 St., New York 17, N. Y.
Circle 137, inside back cover

D-c Motors—Bulletin GEA-6355, 12 pp, describes 1 to 150 hp motors built to NEMA standards. General Electric Co., Schenectady 5, N. Y.
Circle 138, inside back cover

Rotary Switches—Bulletin 456, 11 pp, describes circuit selectors and stepping relays. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio
Circle 139, inside back cover

Magnetic Materials—Bulletin GC-106A, 11 pp, describes permanent magnets, tape wound cores, cut cores, powder cores and gives properties. Arnold Engineering Co., Marengo, Ill.
Circle 140, inside back cover

Magnetic Alloys—Bulletin TC-101A, 27 pp, describes properties and characteristics. Arnold Engineering Co., Marengo, Ill.
Circle 141, inside back cover

Tungsten and Molybdenum—Booklet, 24 pp, describes properties and charactertistics. Fansteel Metallurgical Corp., N. Chicago, Ill.
Circle 142, inside back cover

Standard Plastic Parts—Catalog, 32 pp, describes handles, balls, knobs, cases, covers, pointers, pulls. Harry Davies Molding Co., 1428 N. Wells St., Chicago 10, Ill.
Circle 143, inside back cover

Metallized Ceramic Coating—Bulletin 1155, 4 pp, describes coating used
(Continued on page 338)

LEADERS IN INDUSTRIAL SAFETY: JOHNSON MOTORS

Industrial safety is as vital to Johnson Motors as the production of fine outboard motors. The fire hazard that die-casting equipment ordinarily creates has been controlled at Johnson through the use of fire-resistant Pydraul hydraulic fluid.

FIRE-RESISTANT PYDRAUL F-9 CHANGES FIRE ZONES TO SAFETY ZONES

275 million hours of actual in-use operation—without a single hydraulic fire—*proves* the safety and dependability of fire-resistant Pydraul hydraulic fluid.

But Pydraul gives you more than safety. You can be sure of long equipment life with low maintenance . . . because Pydraul lubricates like a premium petroleum oil. You'll save money on fluid consumption, too! Pydraul is reclaimable—you can return spillage to the system, use it again and again.

Make a quick check of your hydraulic equipment . . . calculate your fire risk if it's close to hot metal, electrical contacts, open flame or other heat sources. Then talk to a Monsanto representative. He will show you how easy it is to convert to Pydraul . . . giving you a future of positive safety from hydraulic fires . . . at low cost per year.

PYDRAUL MEANS:

Fire Resistance
Excellent Lubricity
High Stability
No Corrosion
Re-use, Again and Again

Write now for new booklet, "PYDRAUL F-9." Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Dept. PYD-2, St. Louis, 1, Mo.

PYDRAUL F-9—First and Only Hydraulic Fluid Listed by Underwriters' Lab.

On May 31, 1955, Pydraul F-9 became the first fire-resistant hydraulic fluid listed by Underwriters' Laboratories. From the Laboratories' Service Card: "The fire hazard of (PYDRAUL) is rated 2 to 3 in accordance with Underwriters' Laboratories, Inc.'s Standard of Classification in which Ether rates 100, Gasoline rates 90-100, Alcohol (ethyl) rates 60-70, Kerosene (100° F. flash) rates 30-40, and Paraffin oil rates 10-20." See Underwriters' Laboratories, Inc.'s guide No. 540 18, File MH6049.

PYDRAUL: Reg. U. S. Pat. Off.

MONSANTO

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU

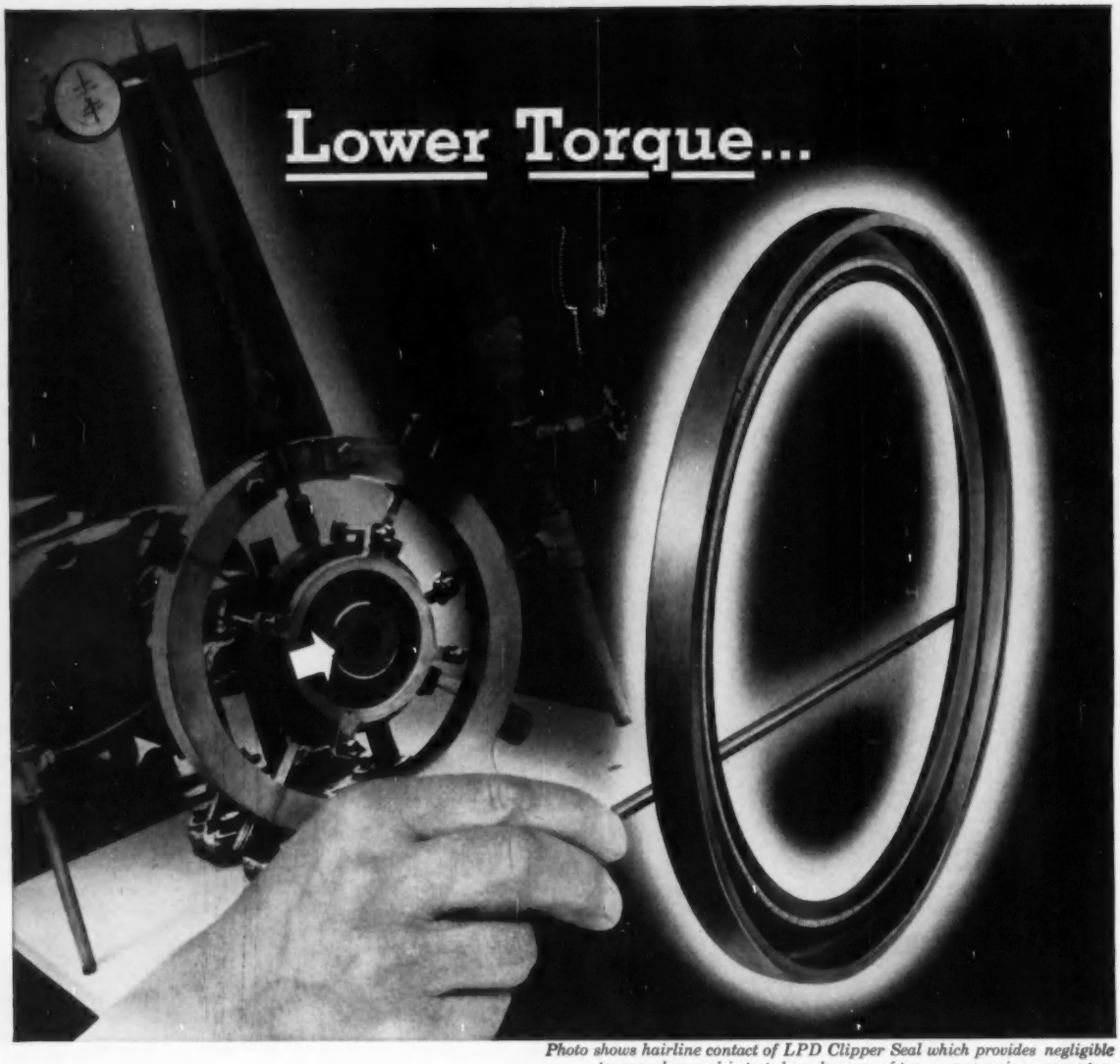


Photo shows hairline contact of LPD Clipper Seal which provides negligible torque when seal is tested on dry run of torque measuring apparatus.

How J-M Clipper Oil Seals cut shaft drag

line contact minimizes interference... provides cooler running

Take a close look at the lip of a Johns-Manville Clipper Seal. You'll see how the bearing area has been narrowed down to a sharp line contact. That's why you get less power consumption and lower operating temperatures when you use Clipper Seals to seal in lubricant, seal out dirt.

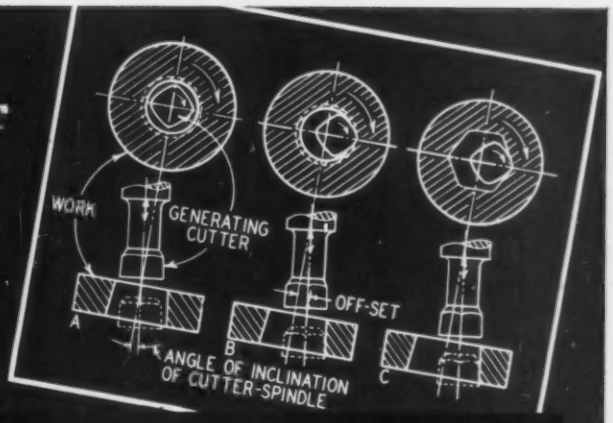
What's more, this line contact requires less lubrication and yet receives far more in proportion to its surface than any other design. It all adds up to greater sealing efficiency and longer seal life for Clipper Seal users. This exclusive line contact feature is provided on all LPD Clipper Seal designs which are adaptable to most applications.

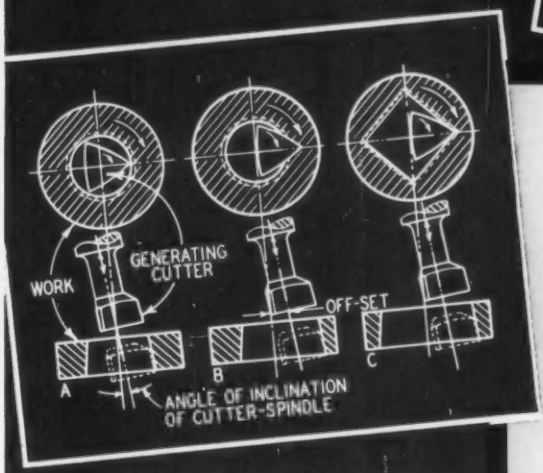
Lower torque is only one of many advantages you get with J-M Clipper Seals. Precision moulded from a variety of corrosion-resistant compounds specially developed for each service, they provide maximum sealing ability, long life, wide adaptability and easy installation. For more information on the complete line of Clipper Seals, write for new 28-page illustrated brochure PK-71A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada: 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

What every designer should know about THE ART OF GENERATING





Generating offers designers many advantages in producing an almost unlimited variety of contours. Produced by the relative motions of points, lines, or surfaces, all generated profiles are combinations of two basic surfaces: curved and straight.

Generating with a reciprocating cutter on the Fellows Gear Shaper is a low-cost method of producing a wide range of symmetrical or irregular contours, either internal or external. Gear Shaper versatility provides a choice of generating techniques—employing a cutter form conjugate to work shape, introducing a variable movement between cutter and work, or a combination of both methods.

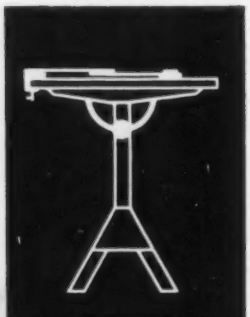
Shown above are some trim dies and the cutters used to generate them: three-sided cutters generate the square holes and four-sided cutters the hexagonal holes. Cutter sides are curved surfaces conjugate to the straight surfaces on the dies. The drawing shows the steps in generating. A special bed tilting mechanism in the Gear Shapers provides a simple adjustment for the required taper angle on the dies.

Many other examples of interest to designers are shown in the booklet, "The Art of Generating with a Reciprocating Tool." Just write any Fellows Office.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices: 319 Fisher Building, Detroit 2
5835 West North Avenue, Chicago 39
2206 Empire State Building, New York 1
6214 West Manchester Avenue, Los Angeles 45

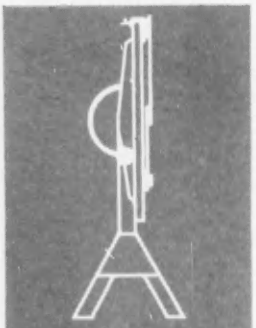
THE PRECISION LINE **Fellows** *Gear Production Equipment*

3 MACHINES IN 1
with Universal's Boardmaster...



HORIZONTAL
Precision accuracy at minimum cost. The ONLY drafting machine convertible IN THE FIELD to all board angles!

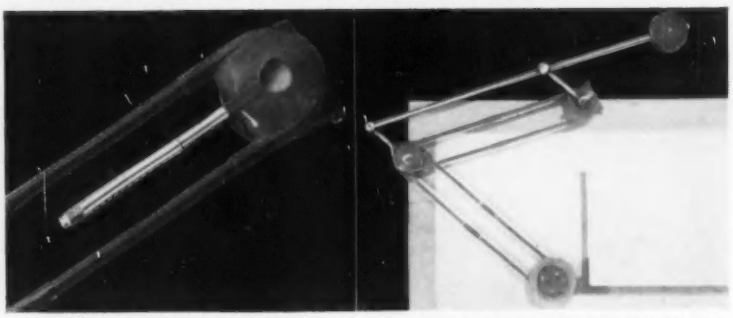
SLOPING
Glides smoothly and freely . . . always in balance. No tiring friction drag. No jockeying into position.



VERTICAL
Convertible ON THE SPOT to 90° through installation of permanent weight arm accessory.

The Drafting Machine with MORE Built-In Advantages

The *only* drafting machine with a built-in *insurance policy* . . . completely protecting your investment against changing board angle requirements. You get the drafting machine suited for your immediate needs — yet you know full well that it can be quickly and easily adapted on the spot to any other board angle. No other drafting machine offers you this unusual feature of "3 Machines In 1". Order from your dealer or write direct for illustrated bulletin.



CARTRIDGE-TYPE STABILIZERS FOR BOARD ANGLES UP TO 20°
Only the Universal Boardmaster spring balances BOTH upper and lower arms . . . eliminating holding by friction . . . assuring easy, effortless movement on sloping boards.

WEIGHT STABILIZER ATTACHMENT FOR BOARD ANGLES UP TO 90°
This rugged, easily attached unit automatically provides frictionless balancing at board angles from horizontal to vertical . . . for use with adjustable-type vertical drawing boards.

FIRST SINCE 1901
UNIVERSAL
DRAFTING MACHINE CORPORATION
7960 LORAIN AVENUE • CLEVELAND 2, OHIO

with hard solders and discusses bonding properties; also used to provide a surface to which a metal part or other metallized ceramic parts may be hard soldered up to 2200 F. Frenchtown Porcelain Co., 160 Muirhead Ave., Trenton 9, N. J.

Circle 144, inside back cover

Stampings in Small Lots—Form 151, 23 pp, discusses design of metal stampings and describes tooling and production requirements, equipment and practice. Dayton Rogers Mfg. Co., 2824 - 13 Ave. S., Minneapolis 7, Minn.

Circle 145, inside back cover

Power Take-Off and Reduction Gears—Bulletin 129-C, 7 pp, describes gearing units for internal combustion engines. Twin Disc Clutch Co., Racine, Wis.

Circle 146, inside back cover

Pumps—Catalog 56, 8 pp, describes centrifugal and gear types for coolants and for circulating and agitating applications. Graymills Corp., 3705 N. Lincoln Ave., Chicago 13, Ill.

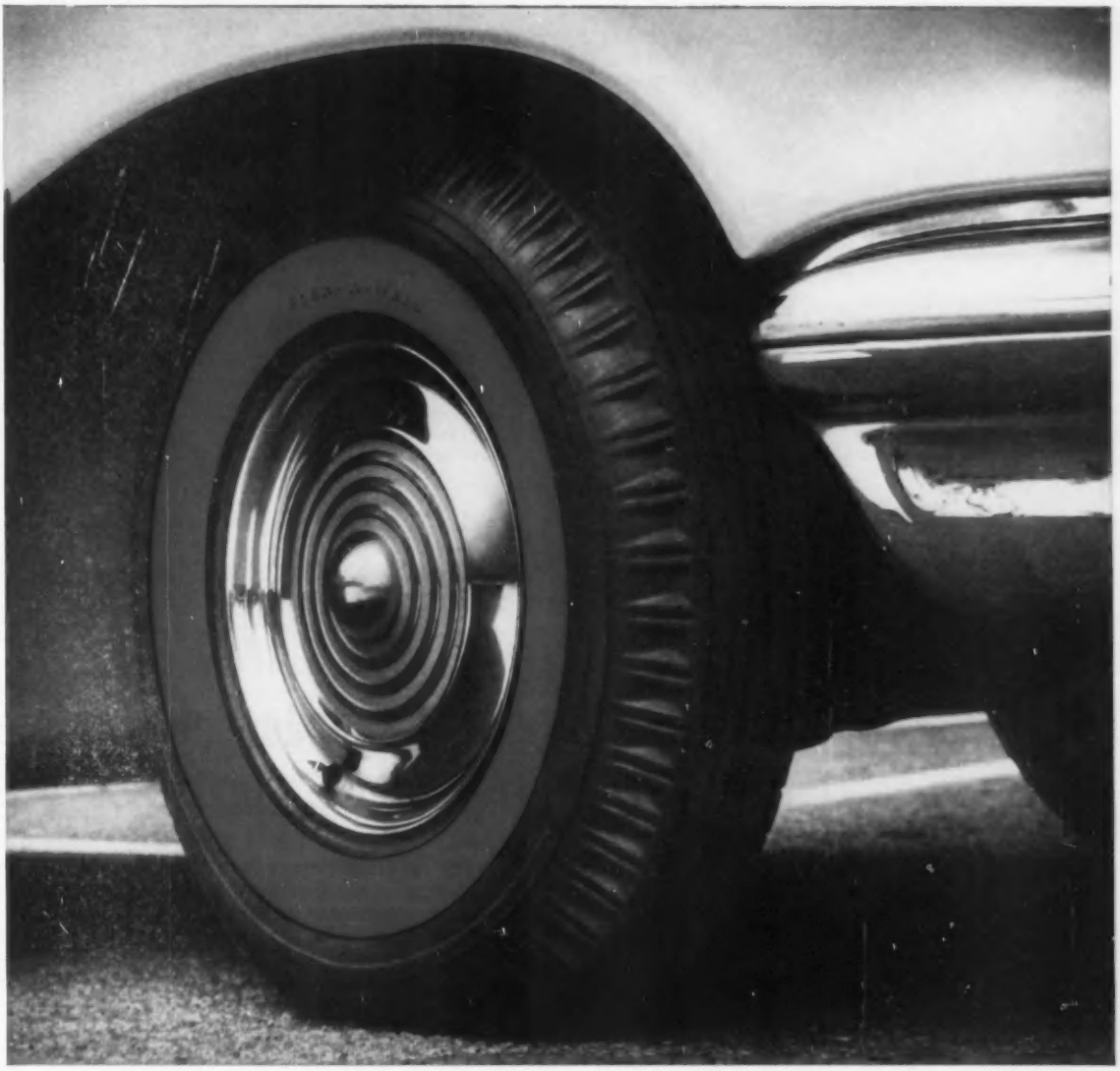
Circle 147, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Aluminum Castings—Handbook, 130 pp, discusses sand casting, permanent-mold casting and die casting and explains various pig and ingot classifications, common alloying elements, and principal alloy characteristics. Tables of data show properties and fabricating characteristics. Casting design section discusses section thicknesses, rib designs, bosses and lugs, pockets, fillets, blending, finishing allowances, locating points, allowances for draft and shrinkage. Table of contents is supplemented by an index of the tabular data and an itemized cross index. Reynolds Metals Co., Desk PR4810, 2500 S. 3 St., Louisville 1, Ky.

Electric Cord Sets—This is a new four-section circular computor that permits visualization of hundreds of actual sample cord sets. Also has cordage tables, capacity and gage charts. Essex Wire Corp., DeKalb, Ill.



The ring of quality

Colorful, low-cost sidewall rings that can be quickly installed on tires are now contributing to the luxury-look of today's new cars. They're inexpensive, stay brilliant for life, wash bright in seconds, out-last tires. A product of The Bearfoot Sole Co., Wadsworth, Ohio, these rings are available in a variety of colors or in white. They're made of Enjay Butyl Rubber because no other rubber tested could equal its performance in severe laboratory and road tests. The Enjay Butyl label on the Flex-A-Wall ® carton assures the buyer of outstanding quality.

Find out for yourself the many technical advantages of Enjay Butyl—the rubber that is outperforming natural and other types of rubber in a wide variety of industrial and consumer applications. For full information, and for technical assistance in the use of Enjay Butyl, write, wire or phone the Enjay Company.

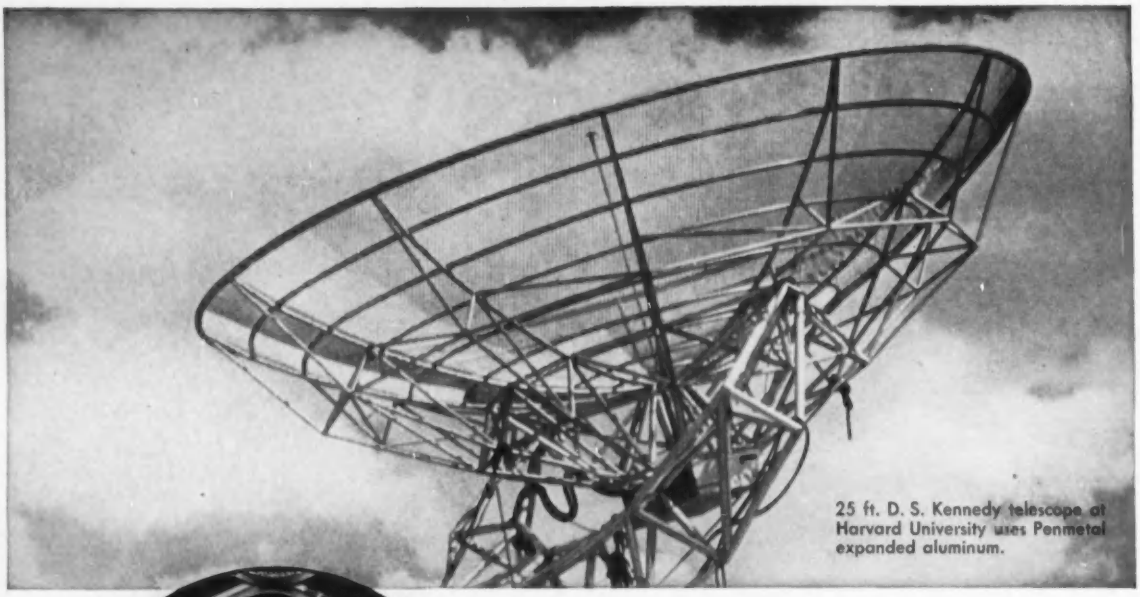
ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

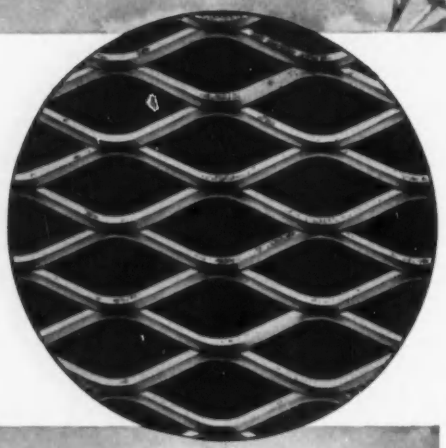
ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

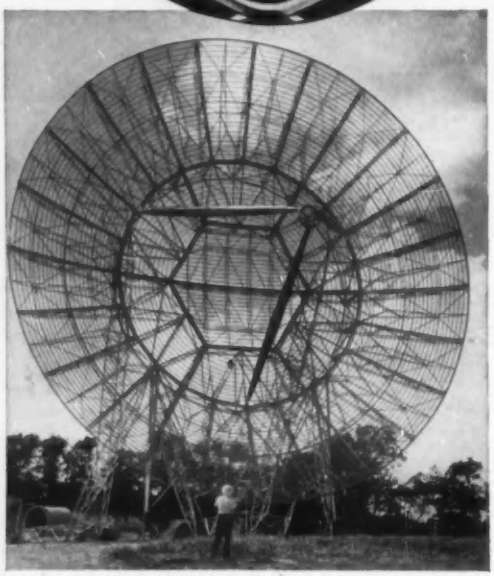
Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.



25 ft. D. S. Kennedy telescope at Harvard University uses Penmetal expanded aluminum.





Penmetal expanded aluminum covers entire area of 60 ft. Trans-Horizon antenna.

Why D. S. Kennedy & Co. prefers expanded aluminum for Radar Antennas

Over the past five years Penmetal has supplied a great deal of expanded aluminum to leading manufacturers of microwave and radar antennas. An example is D. S. Kennedy and Company of Cohasset, Mass.—many of whose developments have become standard specifications in the industry. They use Penmetal expanded aluminum to cover the entire area within the outer periphery of their antennas. Reasons:

- **EXTREME LIGHTNESS**—large areas can be covered with a minimum of weight.
- **MAXIMUM OPEN AREA**—for minimum wind resistance.
- **CORROSION-RESISTANT**—for long life under all weather conditions.
- **LOW COST**—large areas can be covered economically.
- **EASILY FABRICATED**—with standard tools.

As we have done with D. S. Kennedy & Co., Penn Metal will work closely with your engineers in producing special-purpose meshes for your requirements.

Best way to success when you make radar and microwave antennas is Penmetal expanded aluminum. Write for free folder which describes this material in detail.

PENN METAL COMPANY, INC.

General Sales Office: 205 East 42nd Street, New York 17, N. Y.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Chicago, Detroit, Dallas, Seattle, San Francisco, Los Angeles, St. Louis, Parkersburg

Penmetal

PM-96

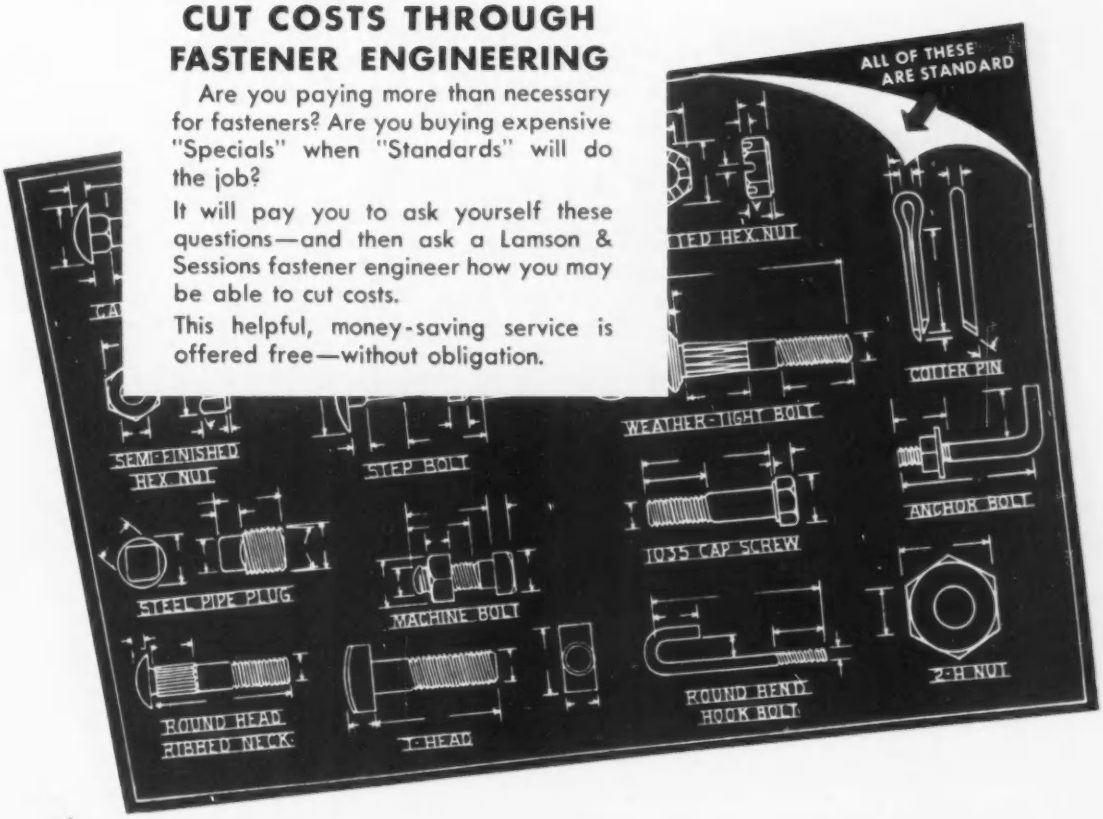
Do You *really* need that SPECIAL FASTENER?

CUT COSTS THROUGH FASTENER ENGINEERING

Are you paying more than necessary for fasteners? Are you buying expensive "Specials" when "Standards" will do the job?

It will pay you to ask yourself these questions—and then ask a Lamson & Sessions fastener engineer how you may be able to cut costs.

This helpful, money-saving service is offered free—without obligation.



The LAMSON & SESSIONS Co.

1971 West 85th Street · Cleveland 2, Ohio

PLANTS AT CLEVELAND AND KENT, OHIO · BIRMINGHAM · CHICAGO

WISH I HAD ORDERED FROM GARRETT

They never let you down on deliveries when you have to keep production going full speed.

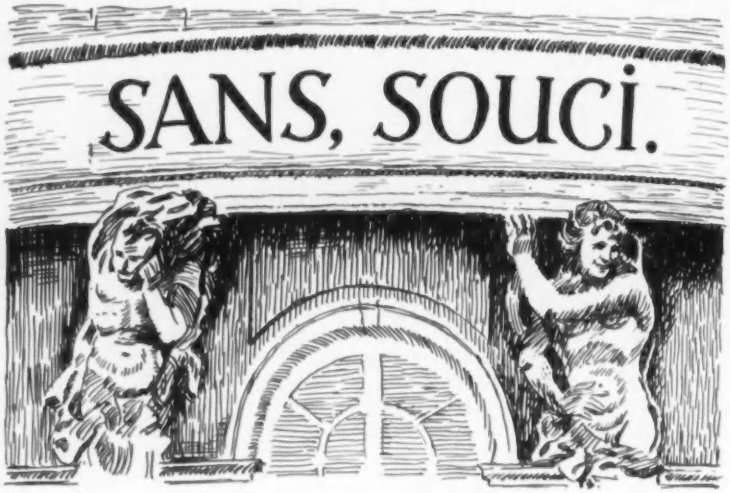
You get *what* you order *when* you order it . . . from Garrett. No waiting for late shipments. You can't beat Garrett service. No worries about Garrett . . . quality. Every Garrett washer, hose clamp, stamping or assembly is right up to the peak of quality. High quality is assured by Garrett's statistical quality control system.

Next time no more headaches for me. I'll order from Garrett. Why don't you do the same when you need . . .

LOCK WASHERS
FLAT WASHERS
HOSE CLAMPS
STAMPINGS

Manufactured by
GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

Garrett
OF PHILADELPHIA



Ad Libbing by The Editor

Nature abhors perfection. Indeed, anything that is perfectly pure does not behave in an ordinary manner. One cannot predict what is going to happen to something that is absolutely pure when it is subjected to a given action.

Good tasting drinking water boils at 212 F and freezes at 32 F, at sea level of course. But perfectly pure water has no taste, is more corrosive than ordinary water, does not boil at 212 F and does not freeze at 32 F. When the temperature gets around 220 F the pure water suddenly "bumps." It acts very nasty. It does not have that beautiful bubbling boiling action that ordinary water has. And at a temperature considerably below 32 F the pure water will crystallize into ice in a flash, but not until a small speck of dirt has contaminated it and serves as the starting point on which the crystal grows.

So we come to the conclusion that the perfectly pure things behave very erratically. But so do the perfectly contaminated things. The sulphur water found in some places in Florida doesn't taste nice at all to one who is not used to it. And the chlorinated water that we find coming out of faucets in some cities is even worse. Nature abhors a vacuum. Likewise, nature is not a perfectionist and seems to keep most things in balance by at least small additives that serve to keep things running smoothly.

Thus we come to the conclusion that there is a happy medium for everything including the extremes of purity and contamination. It is perhaps like the mongrel dog versus the thoroughbred. If the latter gets too thoroughbred he gets so high strung he becomes hard to handle. Also, a mongrel can be such a mixture that he is just about as worthless.

Perhaps one of the most important factors in past history has been the results of the use of "contaminated" language, either written or spoken. Careless use of words, improper sentence construction, putting the punctuation mark in the wrong place and many other little careless things have decided tremendous events in the history of the world. Misunderstandings resulting from ill chosen words have caused wars, murders, wrecks and disasters. Many a business venture has failed because someone misunderstood or failed to grasp the significance of a statement.

"I failed to understand him," or "I didn't know that that is what he meant," have a familiar sound because one hears those statements so often. In spite of the tremendous importance of clarity in both speech and writing, there is perhaps nothing that is as willfully and commonly corrupted. Television programs thrive on meaningless advertising claims and sales slogans. Semantics is considered as an art to be employed to confuse. In some instances confusion of language is used to hide ignorance. Some times it is a mark of dishonesty. At the best, it is not constructive.

Admittedly, scientific developments and world progress requires the addi-

(Continued on page 345)

DESIGNING WITH ALUMINUM

NO. 19

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

PRE-ANODIZING TREATMENTS FOR ALUMINUM

One of the many surface treatments being used for aluminum products is the controlled formation of a relatively thin but durable oxide film. Films of this type are called anodic films and their qualities may be varied according to the particular end use of the product being manufactured. Because they are stable in many natural and man-made environments, they offer excellent resistance to corrosion. Through a variety of processes, it is possible to make anodic coatings that offer attractive decorative finishes, that resist abrasion or that act as electrical insulation. Certain anodic finishes are being dyed to create some of the most brilliant colors available in metal products.

Anodic coatings are fairly simple to apply. The process consists of passing an electric current between the metal and an acid solution in which the metal is immersed. However, surface contaminants that are unavoidable during fabrication will affect the coating adversely if they are not removed before anodizing. Oil and metal contaminants picked up by the aluminum surface will cause darkening or streaking of the anodic film and may even inhibit its formation. Therefore simple pre-anodizing treatments are of great importance in obtaining a uniform, continuous anodic film. The choice of the optimum treatment depends upon the ultimate purpose of the anodic coating.

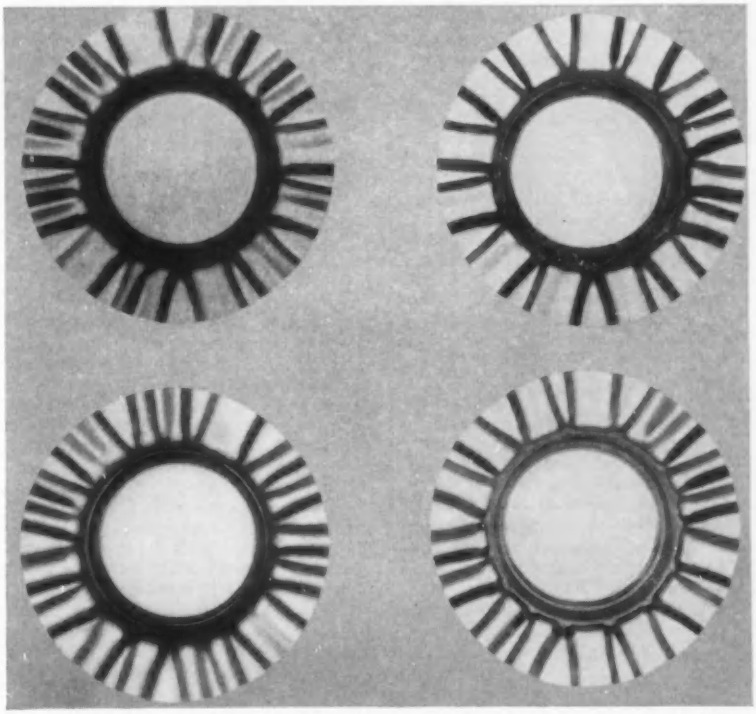
If heavy soil or grease are present, their removal by vapor degreasing or an inhibited alkaline cleaner should be the first step in any pre-anodizing treatment. Both of these cleaning methods are relatively inexpensive, require little handling and may be used to clean inaccessible surfaces thoroughly.

Vapor degreasing may be done by either a batch method or as part of a continuous processing line. The metal to be cleaned is passed vertically through a vaporized solvent such as trichlorethylene or perchlorethylene. In less than a minute the vapor, which condenses on the cool metal and runs off, effectively removes normal soil. When the oily or greasy contamination is extremely heavy, the metal may be wiped with a solvent before entering the vapor degreaser.

Inhibited alkaline cleaners, 4 to 8 oz. per gallon of water, are generally operated at 160F to 180F. The metal to be cleaned may be sprayed or immersed in the solution for two to five minutes, after which it is rinsed in water. When cleaning parts that have small crevices, a quick dip in dilute nitric acid may be necessary as an additional rinse to remove residues from the cleaning solution. These parts are then water rinsed again before proceeding to the next finishing treatment.

For General Use

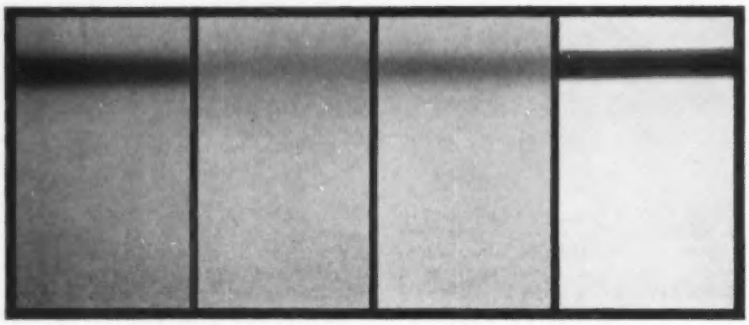
A caustic etch is one of the more common treatments used for preparing aluminum surfaces for anodizing. A typical bath would contain five per cent caustic soda. Numerous proprietary compounds of this type are available. The metal to be etched is immersed in this bath, which is usually maintained at 160F, for a period of two to five minutes. A lustrous, satiny finish can be obtained by caustic etching certain alloys, and the depth of the etch can be controlled by varying temperature, time or concentration of caustic. Variations in either the etching conditions or in the etchants may also be used for creating different shades, or degrees of total reflectivity. Sodium fluoride is frequently added to caustic etch solutions to obtain a desired effect. This addition imparts a finer, more uniform etch to the aluminum surface.



TOP: Anodized and dyed ashtrays. BOTTOM: Anodized natural color ashtrays. Normal good pre-anodizing treatment was used on ashtrays at left; normal good pre-anodizing treatment, plus Kaiser Aluminum bright dip, used on ashtrays at right.

Still finer etching can be obtained by using an acid fluoride bath which produces a white surface that has high total reflectivity. A solution of this type,

CONTINUED ON NEXT PAGE ➡



Alloy 5357 sheet anodized after various pretreatments. Note differences in specular reflectivity shown by black bar mirrored on surfaces.

which is used in finishing diffuse light reflectors, is made of a mixture of sulfuric and hydrofluoric acids.

For Minimum Loss of Metal

To clean aluminum with a minimum loss of metal prior to anodizing, a chromic-sulfuric acid mixture is used. This mixture effectively removes oil stain, oxide and heavy metal inclusions. However, it attacks the aluminum only slowly. Consequently, the anodized surface may not appear as uniform as a surface prepared with a caustic or acid etch treatment. A typical mixture of this type would contain 3.5% by weight chromic acid (anhydride) and 17.5% by weight of concentrated sulfuric acid (specific gravity 1.84). The bath is operated at 180F, and the aluminum is immersed in it for about five minutes. As in the case of caustic or acid etching, the operation can be controlled by changing any of the variables in the process.

For Decorative Purposes

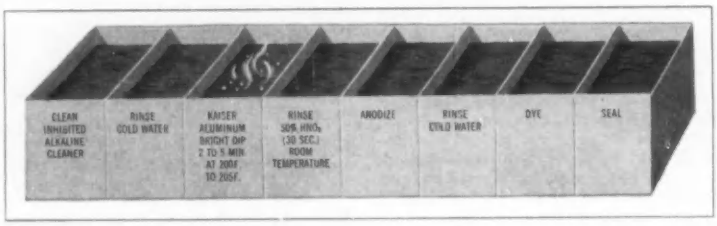
One of the chief purposes of anodizing aluminum is to provide a clear, highly reflective coating for decorative applications. The appearance of giftware, electrical appliances, automobiles, and many other products is being enhanced with brightly anodized aluminum trim of a functional or purely decorative nature. In many products, dyes are being used to add color to this metallic sparkle.

To create this attractive anodized finish the brightening process which precedes anodizing must have a uniform action across the entire surface of the metal. Several types of brightening processes are available. An electrochemical process, requiring the passage of an electric current between the metal and a special acid or alkaline bath in which it is immersed, is used on such highly polished items as light beam reflectors. Concentrated acid baths requiring no electricity during immersion may be used for cleaning and brightening a great many aluminum alloys. Unfortunately, these processes are somewhat expensive and the fumes given off during operation can create a hazard to workmen.

Dilute acid solutions are generally easier to handle and are quite effective on most alloys. Furthermore, dilute acid baths are considerably less expensive to prepare and maintain. Kaiser Aluminum Bright Dip, introduced a few years ago, is a dilute acid brightener which is being used by many anodizers of aluminum end products that depend on a pleasing appearance to increase their sales appeal.

Normal dipping time for Kaiser Aluminum Bright Dip is two to five minutes, and the bath is maintained at 200F to 205F. A flow sheet for using this Bright Dip in finishing an aluminum item which was to be color-anodized would include these steps:

1. Clean
   Inhibited alkaline cleaner
2. Rinse in cold water
3. Kaiser Aluminum Bright Dip
   2 to 5 minutes at 200F to 205F
4. 50% HNO_3 rinse (30 sec.)
   room temperature
5. Rinse in cold water
6. Anodize
7. Rinse in cold water
8. Dye
9. Seal



For other applications, such as in the architectural field, specialized anodizing techniques may be required. Techniques of this sort are the subject of continuous study by Kaiser Aluminum's Department of Metallurgical Research. Further information concerning pre-anodizing treatments may be obtained by contacting the Kaiser Aluminum sales office listed in your telephone directory, or one of our many distributors. Kaiser Aluminum and Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., 919 North Michigan Avenue, Chicago 11, Illinois; *Executive Office*, 7679 Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

see our catalog in
PRODUCT DESIGN FILE
or write for copy

setting the pace—in growth, quality and service

Kaiser Aluminum distributors listed on next page

Kaiser Aluminum Distributors

GIVE YOU PROMPT SERVICE

ATLANTA, GEORGIA
Warehouse Division, Atlantic Steel Co. Phone: Emerson 3451
BALTIMORE, MARYLAND
Hill-Chase Steel Co. of Maryland Phone: Peabody 2-7300
BEAUMONT, TEXAS Standard Brass & Mfg. Co. Phone: 4-2641
BOSTON METROPOLITAN AREA
Bridgeport, Conn. A. R. Purdy Co. Phone: Edison 6-3531
Hawkridge Bros. Co. Hubbard 2-8600
Zurbach Aluminum Co. Phone: Monument 6-1400
CHICAGO METROPOLITAN AREA
Fullerton Steel & Wire Co. Phone: Merrimac 7-2700
Korhumel Steel & Aluminum Co. Phone: Ambassador 2-6700
Evanston, Illinois
Miratile Mfg. Company Phone: Hudson 8-2200
(Serves House Trailer Industry only)
CINCINNATI, OHIO Morrison-Drabner Steel Co. Phone: Wabash 1-4480
CLEVELAND, OHIO
Copper & Brass Sales, Inc. Phone: Endicott 1-6757
Nottingham Steel & Aluminum Company Phone: Atlantic 1-5100
DALLAS, TEXAS
Delta Metals, Inc. Phone: Logan 7443
Earle M. Jorgensen Co. Phone: Riverside 1761
DAVENPORT, IOWA
Nichols Wire & Aluminum Co. Phone: 3-1895
DETROIT, MICHIGAN
Alloy Steels, Inc. Phone: Texas 4-3890
Copper & Brass Sales, Inc. Phone: Lorain 7-3380
GRAND RAPIDS, MICHIGAN
Copper & Brass Sales, Inc. Phone: Empire 1-6681
HONOLULU, T. H. Permanente Cement Co. Phone: 5-2541
HOUSTON, TEXAS
Earle M. Jorgensen Co. Phone: Orchard 1621
Standard Brass & Mfg. Co. Phone: Capitol 5-6531
INDIANAPOLIS, INDIANA
Hubbell Metals Inc. Phone: Walnut 5-9261
F. H. Langsenkamp Company Phone: Imperial 4321
KANSAS CITY, MISSOURI Hubbell Metals Inc. Phone: Baltimore 1-7760
LOS ANGELES, CALIFORNIA
Eureka Metals Supply Co. Phone: Mutual 7286
Earle M. Jorgensen Co. Phone: Lorain 7-1122
Reliance Steel & Aluminum Company Phone: Adams 3-3193
MEMPHIS, TENNESSEE Hubbell Metals Inc. Phone: Jackson 5-2676
MIAMI, FLORIDA Fullerton Metals Co. Phone: 84-3165—84-2490
MILWAUKEE, WISCONSIN
Korhumel Steel & Aluminum Corp. of Wis. Phone: Evergreen 4-6000
MINNEAPOLIS, MINNESOTA
Korhumel Steel & Aluminum Co. Phone: Geneva 2661
NEW ORLEANS, LOUISIANA
Orleans Steel Products Co., Inc. Phone: Raymond 2116
Standard Brass & Mfg. Co. Phone: Audubon 1381
NEW YORK METROPOLITAN AREA
T. E. Conklin Brass & Copper Co., Inc. Phone: Walker 5-7500
A. R. Purdy Company, Inc., Lyndhurst, N. J.
Lyndhurst: Phone Webster 9-8100 New York: Phone Chelsea 3-4455
Newark: Phone Humboldt 2-5566
OAKLAND, CALIFORNIA
American Brass & Copper Co. Phone: Higate 4-2366
Gilmore Steel & Supply Co. Phone: Glencourt 1-1680
Earle M. Jorgensen Co. Phone: Higate 4-2030
PHILADELPHIA, PENNSYLVANIA
Hill-Chase & Company, Inc. Phone: Delaware 6-5400
PITTSBURGH, PENNSYLVANIA
William M. Orr Co., Inc. Phone: Churchill 2-3000
PORT ARTHUR, TEXAS Standard Brass & Mfg. Co. Phone: 5-9377
PORTLAND, OREGON Eagle Metals Inc. of Oregon Ph.: Tuxedo 5201
SAN FRANCISCO, CALIFORNIA
Gilmore Steel & Supply Co. Phone: Klondike 2-0511
Earle M. Jorgensen Co. Phone: Mission 7-7800
SEATTLE, WASHINGTON Eagle Metals Company Phone: Lander 9974
SHREVEPORT, LOUISIANA Standard Brass & Mfg. Co. Phone: 2-9483
SPOKANE, WASHINGTON Eagle Metals Company Keystone 0587
ST. LOUIS, MISSOURI Hubbell Metals Inc. Phone: Franklin 1-0212
SYRACUSE, NEW YORK A. R. Purdy Co., Inc. Phone: Syracuse 72-6677
TULSA, OKLAHOMA Earle M. Jorgensen Co. Phone: 85-1511
WATERBURY, CONNECTICUT Hawkridge Bros. Co. Plaza 6-8121
WICHITA, KANSAS General Metals, Inc. Ph.: Amhurst 7-1208, 7-1209

tion of new words to the vocabulary. In most instances the new words are adopted from a foreign language. In other instances, the new word is a compounding of existing words to build a descriptive picture. When the railroad came into existence the Frenchmen called it a chemin de fer, meaning a road of iron. English speaking people called it a road of rails or a railroad. On the other hand, when the automobile came along it derived its name from the compounding of automatic and mobility. The Frenchman put his automobile in a shed, the French name for which is garage. And that is the word that was adopted by the English speaking people to denote the "shed" in which the automobile is kept.

However, many word derivations are not of the same nature. During the war the world witnessed probably the height of language stupidity when the "boys in Washington" took it upon themselves to corrupt their written language to a point where in many instances it was completely ununderstandable. One man gave it the name "gobbledygook" and that was probably as good a name for it as anything. The word "gobbledygook" is meaningless and the speech and writings that came out of the offices of the bureaucrats was equally meaningless. I have always been convinced that much of that writing was born of ignorance.

Engineers and scientists are rather fortunate in having a universal language that can be understood the wide world over. It is a language that defies corruption. The moment it is "corrupted" it is no longer usable. As a matter of fact, if the language is misused it proclaims the fact in indisputable terms. It is the language of mathematics. And closely related thereto is the symbolized language of chemistry. I have often thought that perhaps one of the reasons that engineers find it so extremely difficult to express themselves is that they attempt to do so with the precision of mathematics. Of course that is impossible for anyone to do. In mathematics every symbol has only one meaning, whereas in language there are many shades of meaning for most words.

So when I say that I must stop now it may mean that I am obliged to, that I have been ordered to or simply that I want to stop and do something else. —G. F. N.

First costs often are only part of the total cost of plastic components. Poorly designed or inaccurately produced plastic parts can mean excessive inspection and assembly costs in your plant and a high failure rate, as well. American's *precision production* saves you money by eliminating these hidden cost factors and thus keeping your *total cost* per part to the barest minimum. That is why so many exacting buyers say, "We turn to American *first* for our plastic parts—because they are precision made."

American Plastics is equipped to give you full line service—injection, compression, extrusion, multiple-shot injection, and low pressure vacuum assisted forming.

Next time you need plastic parts, try American *first*. Others have for over 50 years! Write or wire Dept. PE

AMERICAN PLASTICS CORPORATION

Subsidiary of Heyden Chemical Corporation
Executive Offices at 342 Madison Avenue
New York N. Y.

20 Years OF OUTSTANDING PERFORMANCE

have made Durakool Tilt-Switches and Timer-Relays the Recognized Standard of Industry.

Now celebrating its 20th year, Durakool, Inc., is proud of the many records of achievement set by its mercury tilt-switches and timer relays.
The basic "Sealed under pressurized hydrogen" principle has been proved on thousands of applications. So successful have they been that they are now the accepted standard of industry:

★ Millions of contacts or cycles without faltering
★ Outlasts the normal equipment life
★ Trouble-free under every practical temperature or humidity condition
★ Low cost

See telephone directory for local distributer, or write.

DURAKOOL INC. • ELKHART, IND., U.S.A.
700 WESTON RD., TORONTO 9, CANADA

Durakool

ABSTRACTS

Long Term Strengths of Reinforced Epoxy Pipe

Abstracted from "Long Term Strengths of Reinforced Epoxy Pipe," by H. D. Boggs, Gen. Mgr., Fibercast Corp.; *Technical Papers, Vol. II*, 12th Annual National Conference, Society of Plastics Engineers,, Cleveland, Ohio, Jan. 1956.

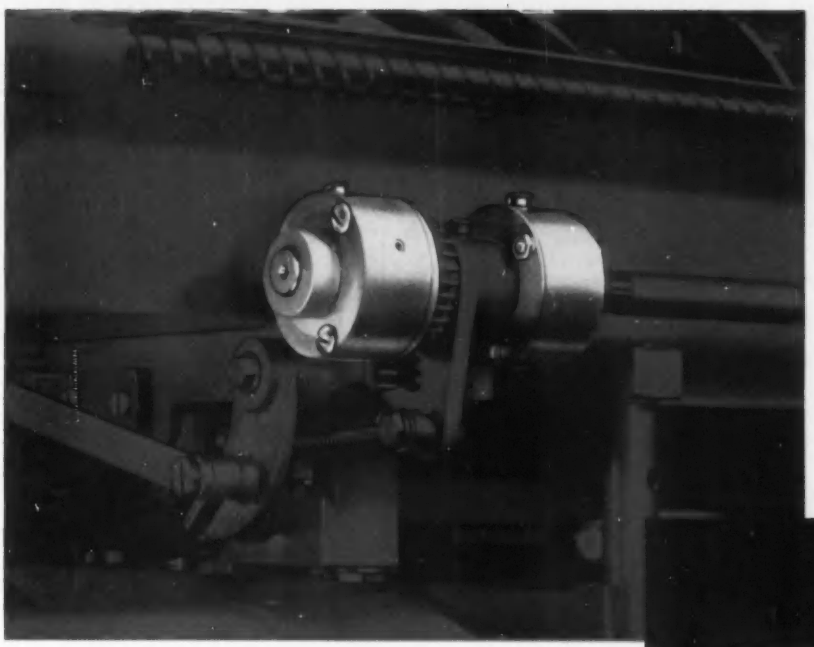
Our pipe is reinforced with layers of braided glass sleeve which we call the "cage." The interwoven stitches of the cage give it body and shape to resist displacement as it is handled. Furthermore, it has a definite geometric pattern and as such is subject to rather precise mathematics. Even so, the development of a strength formula seemed improbable until we began using as the basic fiber strength unit, the published minimum bursting value for the given yarn size. Thereafter, it was merely a matter of multiplying the number of ends in this unit by the trigonometric function of the helix angle of the braid, to arrive at a unit of pounds per inch strength of the braided sleeve, either in hoop tension or in axial tension directions. To reduce the pounds per inch to tension psi in pipe, we added the area factor by using the cast thickness of the reinforced part of the pipe only. We discounted the resin-rich inner liner entirely since it adds only about 2 percent to overall results.

Once we had the basic units selected and checked, formulas quickly became standardized, and we had reached a design point worthy of trial. We designed cages with variations of helix angles, such as fiber sizes, placement of axial fibers. Pipes made were quick-burst or axially pulled, and the recorded actual strengths compared closely with the computed strengths usually exceeding the calculated by about 10 percent. Results were reproducible within quite close limits on repeated tests.

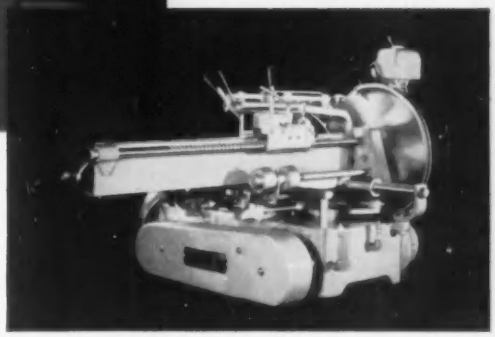
Further studies developed several important design limitations, the outstanding two being as follows: 1. There is a maximum glass loading for a given resin and a given process. 2. Variations in the quick loading rate result in variations in the test values obtained;

(Continued on page 350)

Morse Cam Clutches make slicing machine infinitely more accurate



Series 200 Cam Clutch with retaining end plate removed. This Cam Clutch Series fits standard Series 200 bearing housings.



Here's how they work:

The first Morse Series 200 Cam Clutch controls indexing (though not required on this job, it can handle up to 500 indexes per minute). When driven in one direction, inner and outer members rotate as one unit. When driven in the other direction, one member overruns freely, other member remains stationary. The second Cam Clutch is used to prevent backfeed between strokes.

Versatile, compact clutches can help designers control indexing, free-wheeling, backstopping

This modern slicing machine is infinitely more accurate because a Morse Cam Clutch replaces the old ratchet and pawl mechanism controlling the feed.

When U.S. Slicing Machine, Inc., used the ratchet and pawl, feed variations (slice thickness) could only be made in 1/128-inch increments. Now, the Morse Cam Clutch provides, in effect, a self-contained ratchet with an infinite number of teeth . . . and literally makes it possible for the machine to slice accurately to *any* desired thickness.

In addition, another Morse Series 200 Cam Clutch is used as a backstop device to maintain one-directional drive. It instantly engages to prevent backfeed between forward strokes.

Morse Cam Clutches are manufactured in capacities ranging from 4½ inch-lbs. to 20,000 ft.-lbs. Their low-cost accuracy and dependability make them ideal for a wide range of industrial indexing, overrunning, and backstopping applications.

Like other precision-built Morse power transmission equipment, they are quickly available from your local Morse Distributor. For more information, or free Catalog C 11-54A, call him, or write us today. MORSE CHAIN CO., INDUSTRIAL SALES DIVISION, ITHACA, N. Y.

MORSE

MORSE BW •trademark

POWER TRANSMISSION PRODUCTS

The MATERIAL HANDLING INSTITUTE'S EXPOSITION
Cleveland, Ohio
PUBLIC AUDITORIUM
JUNE 5th THRU 8th, 1956
BOOTH 1201

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

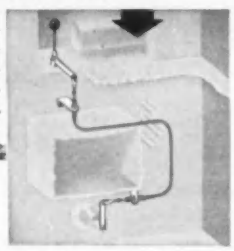
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

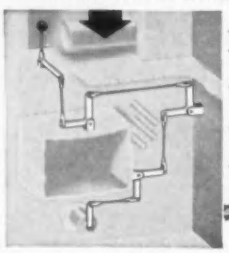
Advantages *of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

TRU-LAY PUSH-PULL

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



MECHANICAL LINKAGES



Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

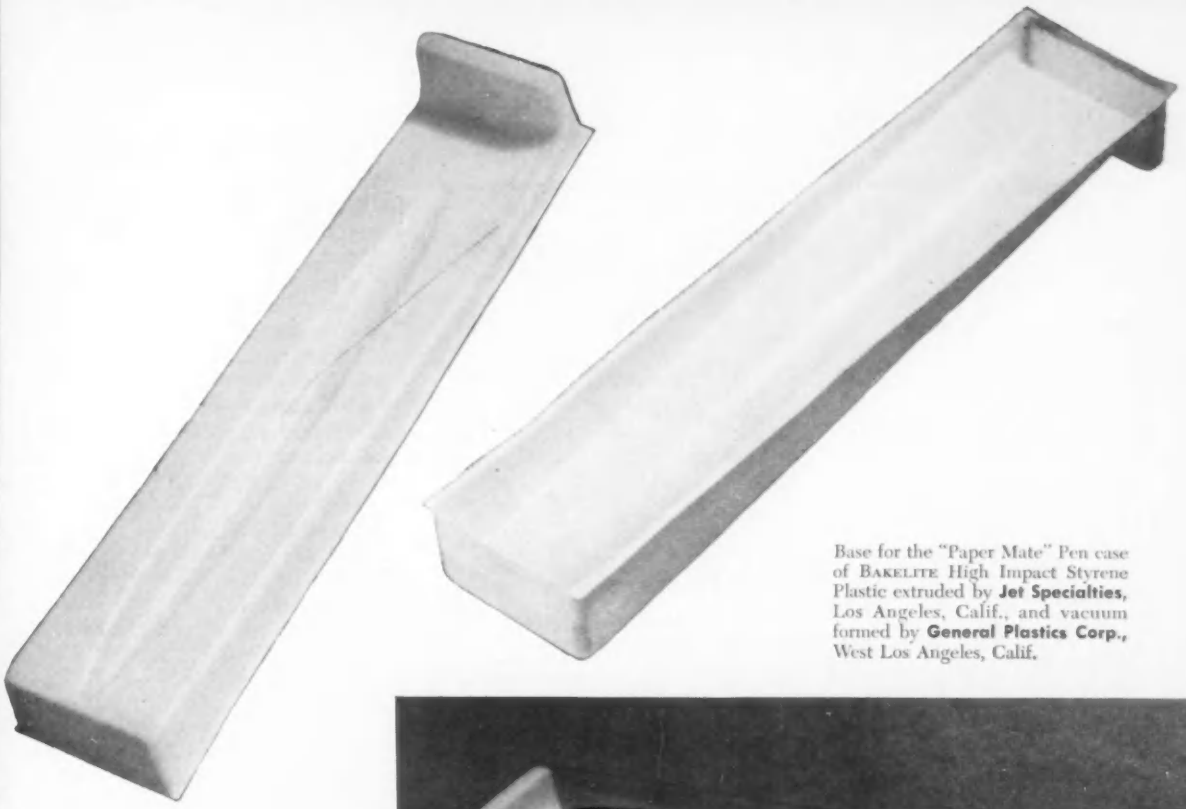
Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

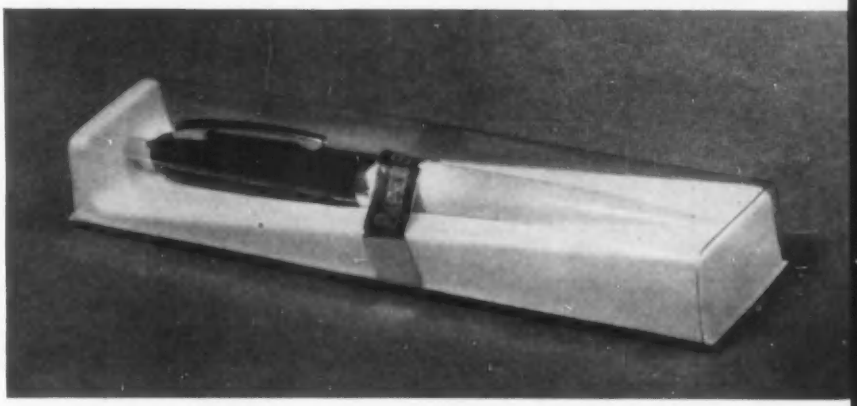
"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.



Base for the "Paper Mate" Pen case of BAKELITE High Impact Styrene Plastic extruded by **Jet Specialties**, Los Angeles, Calif., and vacuum formed by **General Plastics Corp.**, West Los Angeles, Calif.



"Paper Mate" selects BAKELITE Brand Impact Styrene for

Eye-catching display package

There are three important advantages for the Paper Mate Pen Company in this attractive container with base fabricated from Impact Styrene. It's an eye-appealing display that stimulates impulse buying. It's a sturdy package that keeps the pen fresh-looking and salable. And, the base is produced fast and at low cost by vacuum forming from high gloss flat extruded sheets of BAKELITE Impact Styrene, without costly finishing operations.

Your package, product or display may call for this plastic or one of many others; vinyls, phenolics, polyethylenes, styrenes, polyesters or epoxies. The best way to decide is to come to Bakelite Company where you find the greatest variety and the largest resources keyed to your needs. Write Dept. QR-145.

BAKELITE BRAND PLASTICS

See BAKELITE'S exhibit, booths #809, 813, 817, 825, National Plastics Exposition, June 11-15, 1956, New York Coliseum, New York

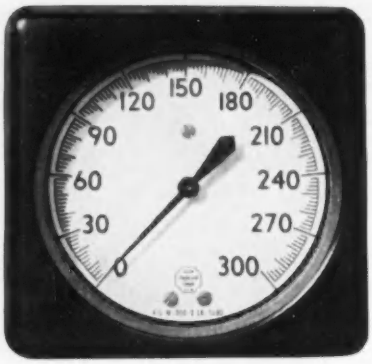
BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

ACCO products

Helicoid Gages

Long-life gages to meet every pressure indicating requirement



Acaloy square case for flush mounting

Acaloy flanged case

For pressure, vacuum or compound service

Ranges from 15 to 20,000 p.s.i.

Tubes of bronze, alloy steel, stainless steel and K Monel for all types of gas or liquid.

Cases are flanged, flangless, flush mounted, square or circular and with white or black dials.

Chemical gages with diaphragms to seal off objectional substances from indicating gage.

Chemical gage with black dial

Only HELICOID has the HELICOID movement

All HELICOID Gages provide the sustained accuracy that only the famous HELICOID—no gears—movement provides.

Write today for the HELICOID G-2 CATALOG

ACCO

Helicoid Gage Division

AMERICAN CHAIN & CABLE

929-D Connecticut Avenue • Bridgeport 2, Connecticut

Better Value

hence it is necessary to define the quick loading rate.

We noted variations of results due to variations in burst loading speeds. While loading speeds on standard testing equipment are standardized, bursting pipe presents more complications. It is important, however, to regulate the speed since all the fibers in the structure are not in the same tension, and the stress is delivered through the resin from fiber to fiber. As long as the loading rate is sufficient to transmit the stress from fiber to fiber before the resin structure or the resin-to-fiber bond fails, the test is within the range of short term failure, and the failure will break the glass structure.

However, it is possible to snap the fibers progressively, beginning with those in greatest tension; hence, loading speed is critical. As we stated, a standard loading speed to burst pipe presents problems since the variation in size alone eliminates the common denominator of a standard-shape pull bar. Unfortunately, coupon testing is worse than no tests, so all tests must be made on full sections to secure the facts. We attempt to maintain a hoop stress loading of 75,000 to 100,000 psi per min resulting in bursts of less than 1 min. We burst each test sample according to plan, such as planned incremental increases in water pressure

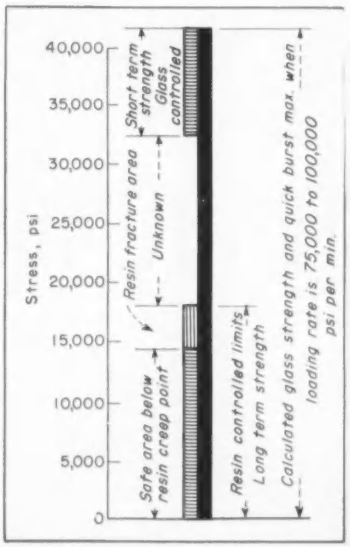
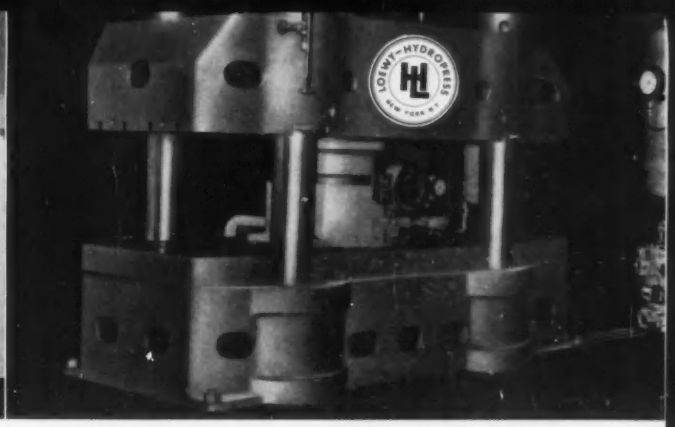


FIG. 1—This is a typical epoxy resin with a hardener curing system. Pipe OD, 3½ in. Reinforced wall thickness, 0.240 in. Mechanism of failure: resin fracture.

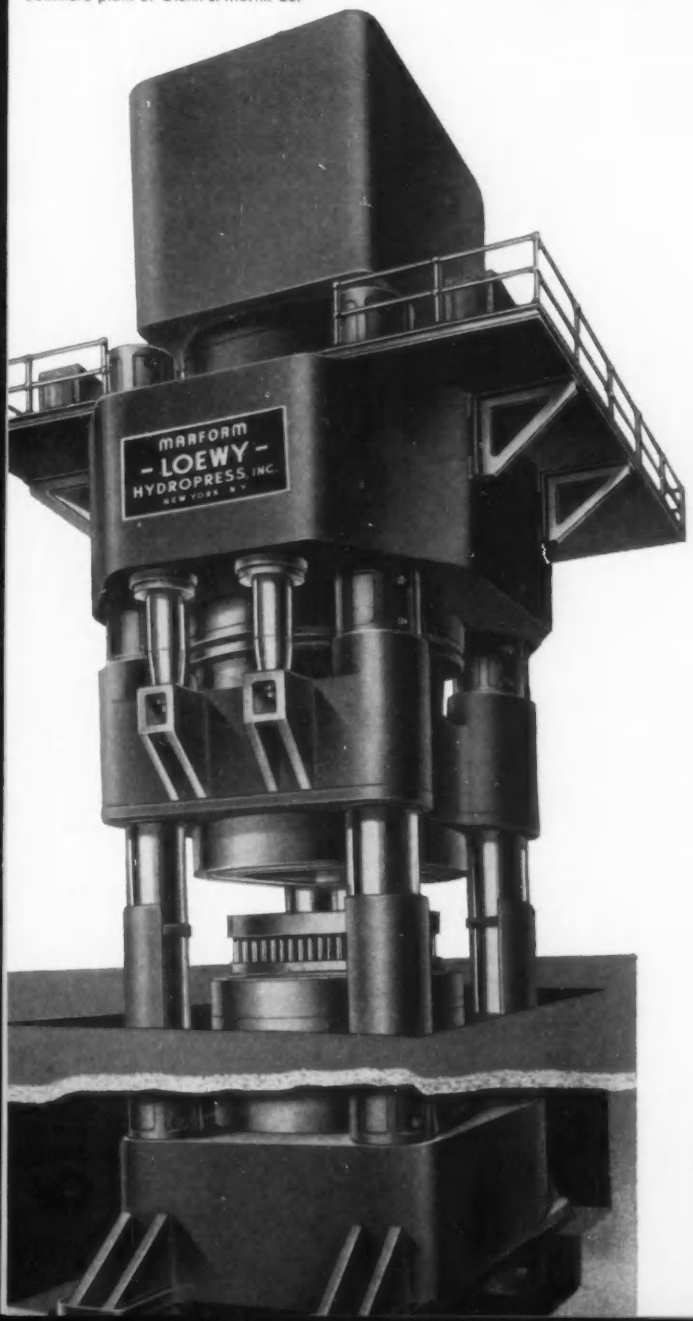
(Continued on page 353)

Above: The 6,500 ton press in action, showing complex pieces being produced in quantities, each in one operation.



Existing presses can easily be converted to MARFORM by installation of an appropriate "package unit." Unit is easily removable, however, not restricting press to MARFORMING.

Below: Artist's conception of 6,500 Ton MARFORM press operating at the Baltimore plant of Glenn L. Martin Co.



LOEWY-HYDROPRESS

MARFORM

presses give better finish, cut production costs over 50%

The MARFORM process combines the economy of the rubber pad process with the accurate forming ability of the steel die. The MARFORM process is ideal for forming parts where surface finish and depth of draw are critical.

Control is the heart of the MARFORM press . . . control which permits precise and stepless regulation of blank holding pressure throughout draw. Tapered and other complex shapes are now possible in one operation. Your production costs are cut because:

- Tooling is extremely cheap.
- Lengthy set-up time is eliminated.
- Production of wrinkle-free, unmarred parts eliminates hand forming.
- Press forms pre-coated blanks, either plated or bonded, metallic or non-metallic.
- Parts have uniform wall thickness.
- High precision: tolerance to $\pm .002''$.
- Embossing is done during forming.

Loewy-Hydropress MARFORM presses can also be used for the Guerin process, for matched steel dies and for other conventional hydraulic press work. For a copy of our catalog describing this versatile equipment, write to Dept. 035, Loewy-Hydropress Division, BLH Corporation, 350 Fifth Avenue, New York 1, New York.

BALDWIN BLH LIMA-HAMILTON

LOEWY-HYDROPRESS
BALDWIN-LIMA-HAMILTON
DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Lima • Hamilton • Loewy-Hydropress • Pelton • Madsen • Standard Steel Works

If you are, we can save you time, money and patience!

Call in Tyer, the company with 100 years' experience in rubber research, development and manufacture.

Tyer's specialized knowledge can help you solve the toughest molded rubber problems, whether they're matters of mold or manufacture.

Our 100th TYER Anniversary

Tyer *Rubber Company*

ANDOVER, MASSACHUSETTS, U. S. A.

TYER RUBBER COMPANY
Industrial Division, Andover, Massachusetts PE-6

Gentlemen:

☐ Please send me the new *Tyer Rubber Engineering Brochure* including technical specifications and relative properties of natural and synthetic rubbers.

☐ Please have Tyer field engineer call on _____ (date)
No obligation, of course.

NAME _____

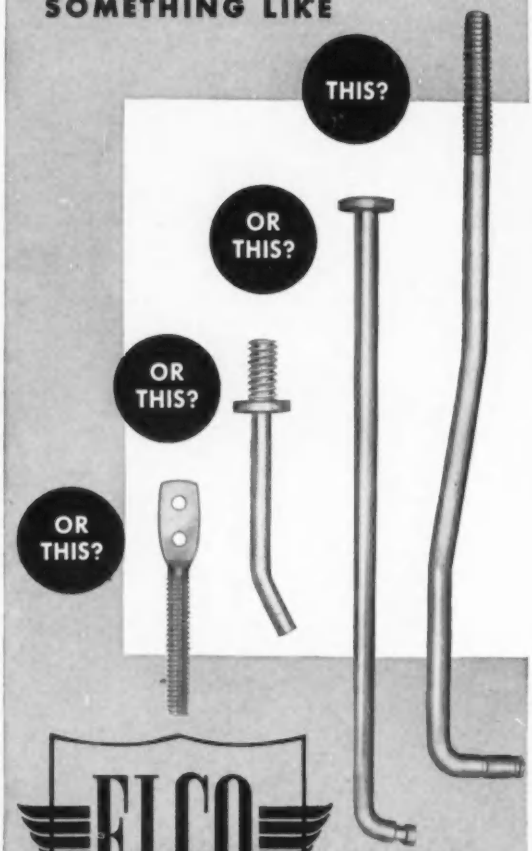
FIRM _____

STREET _____

CITY _____ ZONE ____ STATE _____

DO YOU NEED

SOMETHING LIKE



ELCO

COLD-HEADING PRODUCES THESE AND MANY SIMILAR...

Cold-heading, of course, produces the shapes, forms, knobs, and upsets. The ends are roll-threaded. Kinks, bends, flats, and other forming is done on suitable machines. The *important* consideration is that ELCO has *all* these facilities, and many more — acquired and developed through years of varied experience, together with a store of versatile ingenuity that can mean *lower costs* for you. *Always consult your ELCO representative.*

SUCH AS

- WOOD SCREWS
- MACHINE SCREWS
- MACHINE SCREW NUTS
- TAPPING SCREWS
- THREAD-CUTTING SCREWS
- PHILLIPS AND SEMS SCREWS
- PIPE PLUGS
- STOVE BOLTS
- CAP SCREWS
- LAG SCREWS
- DRIVE SCREWS
- SPECIAL SCREWS
- COLD HEADED PRODUCTS

ELCO TOOL AND SCREW CORPORATION

1958 BROADWAY, ROCKFORD, ILLINOIS

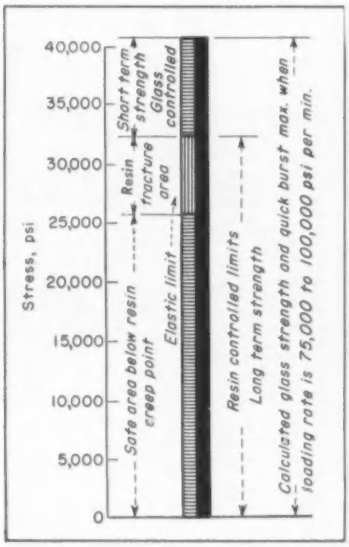


FIG. 2—This is the most nearly ideal resin tested for room temperature applications, but processing is difficult, due to heat distortion point of 130-140 F. Pipe OD, 3½ in. Reinforced wall thickness, 0.240 in. Mechanism of failure; elastic limit of resin.

per second, and test conditions can be reproduced only through attention and plans.

If you will refer to the diagrams you will note we have pictured a "short term" stress area, which is controlled by the glass structure at one end of the scale. At the beginning of the scale is a "long term" stress area. If the resin fails during test, the sample weeps to such an extent that it is usually impossible to sustain a loading rate sufficient to cause failure of the glass structure. This is not important, however, since the pipe has already failed. Failure in the resin body is difficult to detect in pull bar tests, and for this reason pressure testing is superior in permitting observation of the failure mechanism.

Fig. 1 is a stress picture of the behavior of a brittle epoxy resin, whereas Fig. 2 is a picture of a tough epoxy resin. Figs. 3 and 4 are pipes from polyester resin. The reinforcing cage is identical in all pipes, and each pipe was cured under optimum conditions for the resin used. The significance of the illustration is: (1) Safe operating pressures can never be based on ultimate failure data. (2) Creep level, while differing widely, was dependent

(Continued on page 354)

NEW!

LAMINUM® Shims of Aluminum

with all laminations surface-bonded

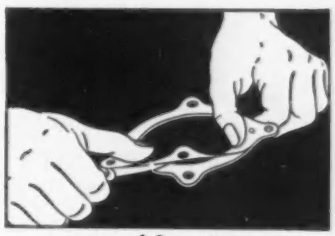
This new type of laminated shim brings you all the advantages of aluminum – light weight, freedom from corrosion and electrolytic action – in shims that P-E-E-L quickly and smoothly for adjustment. They're bonded over their entire surfaces and are made just as carefully and expertly as the brass and steel laminated shims we've been producing for over 40 years.

Laminated aluminum is available either as shims custom-stamped to your blueprint specifications or as laminated sheet stock in thicknesses from .015" to .125", sizes to 20" x 48".

For free sample of material, further information and prices, please write us direct.

Only the Laminated Shim Company gives you shims of Laminum®

they look "solid"



yet p-e-e-l for adjustment

SHIM HEADQUARTERS SINCE 1913

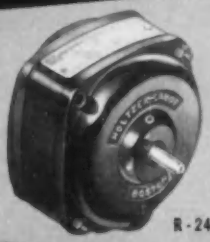
LAMINATED SHIM COMPANY, INC.

Send today for our Engineering Data File

1406 UNION STREET · GLENBROOK · CONNECTICUT

FLASH! Now also made of STAINLESS STEEL in layers of .002" or .003"

HOLTZER -CABOT



R-24 Motor

Synchronous and Induction Capacitor Type Motors

R-25 Motor

R-24. Typical applications for this reversible, 4-pole induction motor are in servo mechanisms, as a balancing motor in recording instruments or as a control motor for voltage regulators. It has low rotor inertia for fast response applications. When operated 2 phase, it can be controlled electronically; or operated single phase as a permanent split capacitor motor.

R-25. Typical uses are for recording instruments, dictating and adding machines. Approximately 2½" in diameter, it is available in either induction or synchronous construction with reversible rotation.

Both the R-24 and R-25 are available with gear case speeds from 1/2 to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single phase, 2 or 3 phase.

HOLTZER-CABOT ESTABLISHED HC NP

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me data sheets on the Holtzer-Cabot R-24 and R-25 Size Motors.

Please have representative call _____ (date)

Name _____

Company _____

Street _____

City _____ Zone ____ State _____

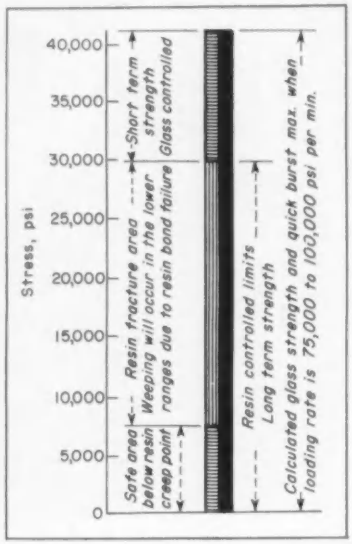


FIG. 3—This is a low modulus polyester. It will withstand close to 1 per cent deformation before bond failure. However, this deformation is caused by 2000 psi water pressure. Pipe OD, 3½ in. Reinforced wall thickness, 0.240 in. Mechanism of failure: bond to glass.

in all cases on the resin characteristics.

Elevated temperatures changed the picture considerably. At 180 F only Fig. 1 resin was operative. Fig. 2 resin became too elastic at 140 F to remain useful, although the resin-to-glass bond did not fail. Neither Figs. 3 or 4 resins would last long at 120 F at very low stress levels, although Fig. 4 resin did show a slower rate of creep to destruction. Furthermore, even at room temperatures it was evident water was entering the glass cage of both Figs. 3 and 4, at a rapid rate so that failure of the resin-to-glass bond was more than 50 per cent. Neither epoxy resin (Figs. 1 and 2) indicated water admission in the slightest. This is the essential difference in the long term picture.

These observations brought us to the following conclusions: (1) Resins control the long term strength; (2) glass reinforcement (up to the maximum loading) operates to reinforce the resin until the glass-to-resin bond fails, or the resin structure fails. The assistance is proportional to the glass loading if the glass loading range is between 25 and 65 per cent by weight of the reinforced structure; (3) A continual growth under stress is a creep,

(Continued on page 357)

MICA IS BEST

TODAY'S EMPHASIS is on speed — both in domestic appliances and industrial applications. Mica is a wonderful insulating material. It has ample mechanical strength, will not react with resistor substances and is unaffected by oils or organic solvents. It will not crack under extreme temperature changes nor lose its dielectric value.

COMMUTATOR MICA INSULATION

Molding Plate — Segment Plate — Mica Rings — Mica Segments — Mica Bushings
Class B and Class H
For all types of starting and generating motors
Accurate to specified dimensions
Properties controlled to assure fullest efficiency of assembly and operation of commutators

FLEXIBLE MICA & COMPOSITES
Class B and Class H

Sheet, roll and tape forms
Formed slot liners

MICA TUBING
Round, square, rectangular
Class B and Class H
Specified dimensions

COIL & SLOT INSULATION
Molded or formed to specified dimensions

Y-26 HIGH HEAT MICA
Completely inorganic. Combines the durability, high electrical insulation value, temperature resistance and high reflective value. It is available in large sheets or full size pieces stamped to specified dimensions.

Tell us your area of interest and we will send you large samples for testing — or, better still, send your drawings for quotation and learn how you too can have better insulation at lower cost.

NEW ENGLAND Mica CO.
INCORPORATED
Waltham 54, Massachusetts

Idea Sparkers

for your next

BEARING PROBLEM

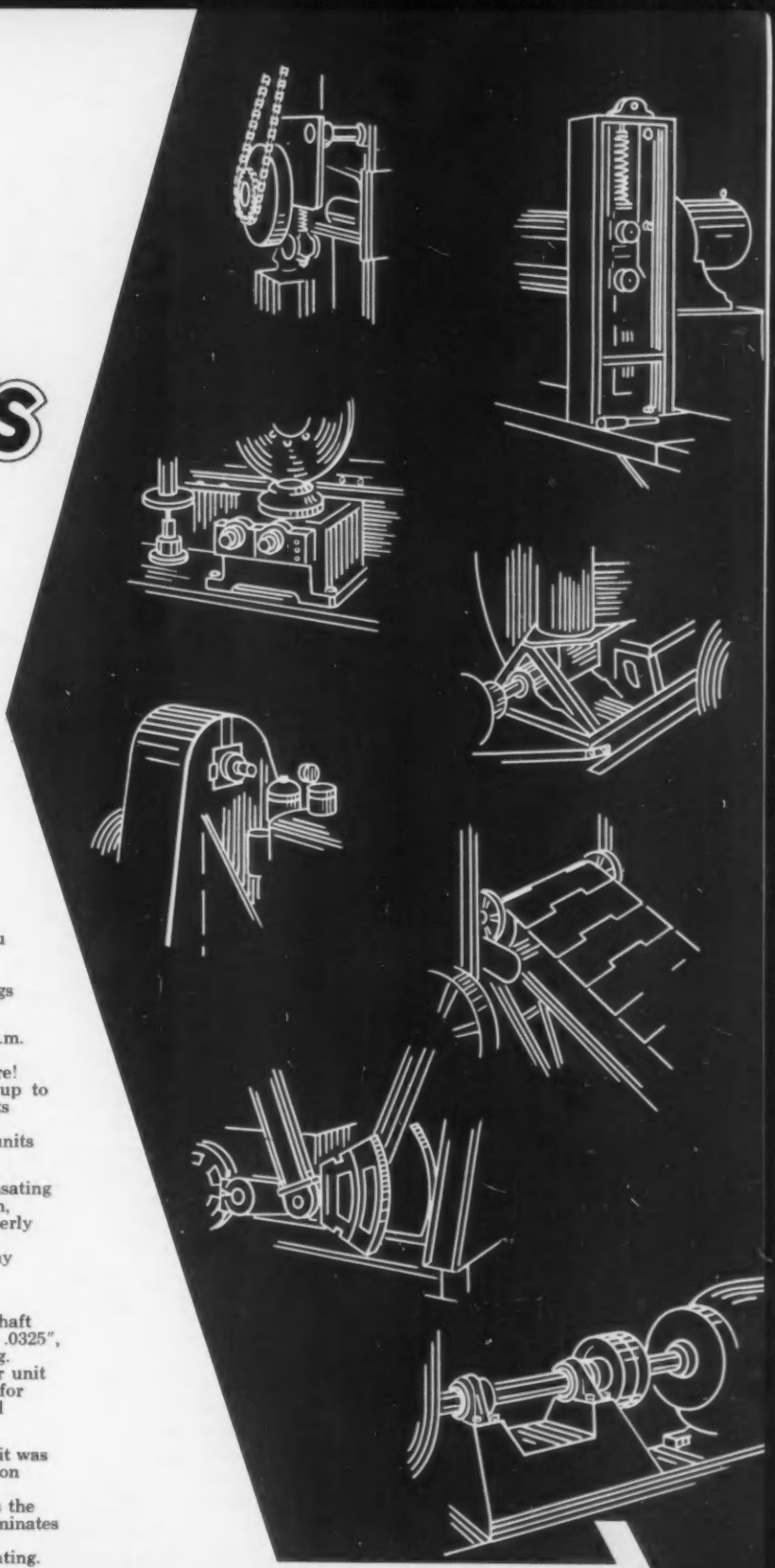
Have you ever compromised design because you had to sacrifice bearing capacity? Perhaps it was due to high operating temperatures, housing materials, or need for seals operating under extremes of dirt or water. Then you will be interested in these "idea sparkers" from designers who used Shafer Self-Aligning Roller Bearings on applications where . . .

. . . operating speeds average 3800 r.p.m. and go as high as 5000 r.p.m. 30% of the time. High temperatures? Sure! Internal bearing temperatures run up to 240°, but these Shafer Cartridge Units have proved that they can deliver the performance and are replacing all units formerly specified in the design.

. . . Micro Lock adjustment, compensating for high wear rates on one application, has added 30% to bearing life formerly experienced. This feature alone has resulted in an annual saving of many thousands of dollars in bearing replacement costs.

. . . moderate overhung load on 5" shaft caused a shaft deflection at load of .0325", resulting in severe overload at bearing. Inherent self-alignment of the Shafer unit now specified, instantly compensates for this deflection, providing the required service life and performance.

. . . size of pillow block housing on unit was working a difficult mounting restriction on the design. Better distribution of metal in the Shafer housing provides the most efficient use of metal . . . eliminates the excess bulk and unnecessary weight, solving the problem of mounting.



TURN THIS PAGE FOR MORE INFORMATION

CHAIN BELT COMPANY

LEADERSHIP . . . through creative engineering

IDEA SPARKERS *(CONTINUED)*

... an advantage was found by another manufacturer for itself as well as its customers. Because of the interchangeability of Shafer components, parts stocking became an easier, less expensive job. Shafer Bearing Division is the only bearing manufacturer that offers this feature.

SHAFER

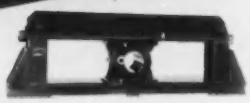
Self-Aligning Roller Bearings

Offer More Capacity — Positive Sealing — Self-Alignment — Housing Strength for All Applications

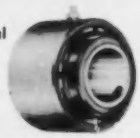
Pillow Blocks: Normal and Heavy Duty from ¾" to 7" shaft sizes, 2 and 4 bolt base types. Also, expansion type and adapter mounting units.

Flange Cartridge Units: Normal and Heavy Duty from ¾" to 5" shafts. Bore tolerance of mountings — plus .002", minus .000".

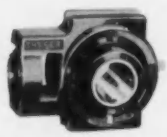
Flange Units: Normal and Heavy Duty from ¾" to 5" shaft sizes. Also available with a flange pilot.



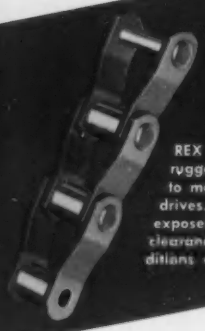
Take-Up and Frame Units: Normal, Heavy and Extra Heavy Duty from 1-15/16" to 4-7/16". Special reinforcements for greater capacity.



Cartridge Units: Normal and Heavy Duty from ¾" to 7" shafts. Cartridge housing drilled and tapped for lubricating fitting.

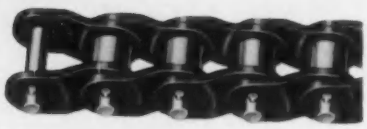


Take-Up Units: Normal and Heavy Duty from ¾" to 4" shafts. Guide slots milled for sufficient clearance to operate on hot-rolled guide bars.



REX ASA ROLLER CHAINS ... precision-built chains for moderate to high-speed drives. Exclusive pitch control system assures longest possible service life.

REX CHABELCO STEEL CHAINS ... rugged, heavy-duty chains for slow- to moderate-speed, heavy-load drives. Ideal for operation in exposed conditions ... built-in clearances permit operation in conditions of dust and dirt.



REX OFFSET SIDE BAR ROLLER CHAINS combine the high-speed service features of ASA roller chain with the strength and flexibility of Chabelco Chains.

CHAIN Belt Company
Dept. DP-1
Milwaukee 1, Wis.

☐ Send me informative literature on Shafer Bearings.
☐ Send me informative literature on Rex Drive Chains.
☐ I would like to have a CHAIN Belt District Sales Engineer call.

NAME .....
COMPANY .....
ADDRESS .....
CITY..... ZONE..... STATE.....

CHAIN BELT COMPANY

MILWAUKEE 1, WISCONSIN

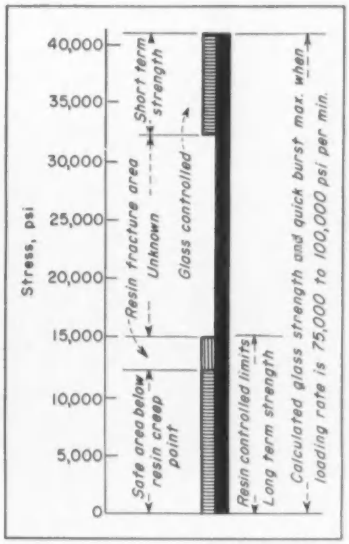


FIG. 4—This is an all-rigid polyester resin. Medium reactivity in curing. Pipe OD, 3½ in. Reinforced wall thickness, 0.240 in. Mechanism of failure: resin fracture and bond to glass. Ultimate stress data do not indicate safe operating pressure; creep depends on resin properties.

resulting in destruction; (4) The factors influencing creep are stress, time and temperature. An increase in any of the three will accelerate creep to failure; (5) Resins useful for sound structural plastics must have the following characteristics: (a) adhesion to glass even under water saturated environment. (b) Modulus of elasticity was in excess of 3.5 million to 4.5 million. (c) Ability to elongate 0.9 to 1.2 per cent without failing or reaching its elastic limit in a structure of 55 percent glass by weight. (d) Retain adhesion and a modulus of 2.5 million min at 200 F. (e) Controlled cross linking to prevent residual shrinkage stresses in the resin body.

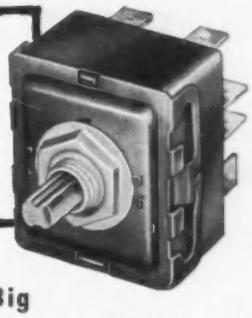
Now the foregoing amounts to just this. The glass cage, made up of bundles of fibers, has to be glued together. Just as in any glue line, the energy of wetting must be very low, the adhesion excellent and resistant to environmental attack. The glue line must stretch without failing at the bond or in the glue body even under repeated or cycled loads. It goes without saying the glass fibers must be clean and free of interference with bonding.

We have reached a safe long term stress level of 14,000 psi in certain rein-

(Continued on page 360)

This Little Switch Goes to Market

. . . in air conditioners, fans, unit heaters, appliances, motor and resistive circuits.



This Little Switch Is Big

Ratings range up to 25 A. at 120 or 240 V., and ½, ¾ and 1 hp at 120 V. and 2 hp at 240 V., A.C. U.L. Approved. (Small D.C. ratings also available.) *But base is only* 1½" x 1¼" x ⅞".

This Little Switch Saves Money

Costs less—permits simplification of your designs. Spindle extensible through base to permit ganging of mechanical and electrical controls . . . spade terminals for quick wiring . . . dummy terminals, if required, to eliminate need for blocks.

This Little Switch Is The NEW "Diamond H" Series 390 Rotary

. . . single or double pole, two to twelve positions with stop as required. Single, two-hole or special mounting arrangements. Completely interchangeable with the widely used "Diamond H" Series 240 switches which are still available.

Write today for complete information to meet your requirements

THE HART MANUFACTURING COMPANY

206 BARTHOLOMEW AVE., HARTFORD, CONN.

NOW! new economies in NYLON GEARS means savings in gear costs up to 90%

Our many years of pioneering and successful production of Nylon Gears, plus new reduced mold charges, can now make even greater economies for you in the use of Nylon Gears. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where a compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication – they mate perfectly with metal gears.

Let our engineers with more than a decade in gear experience show you how Nylon Gears can save you money – let us consider your gear problems during the design process—send blueprints or specs for prompt estimates.

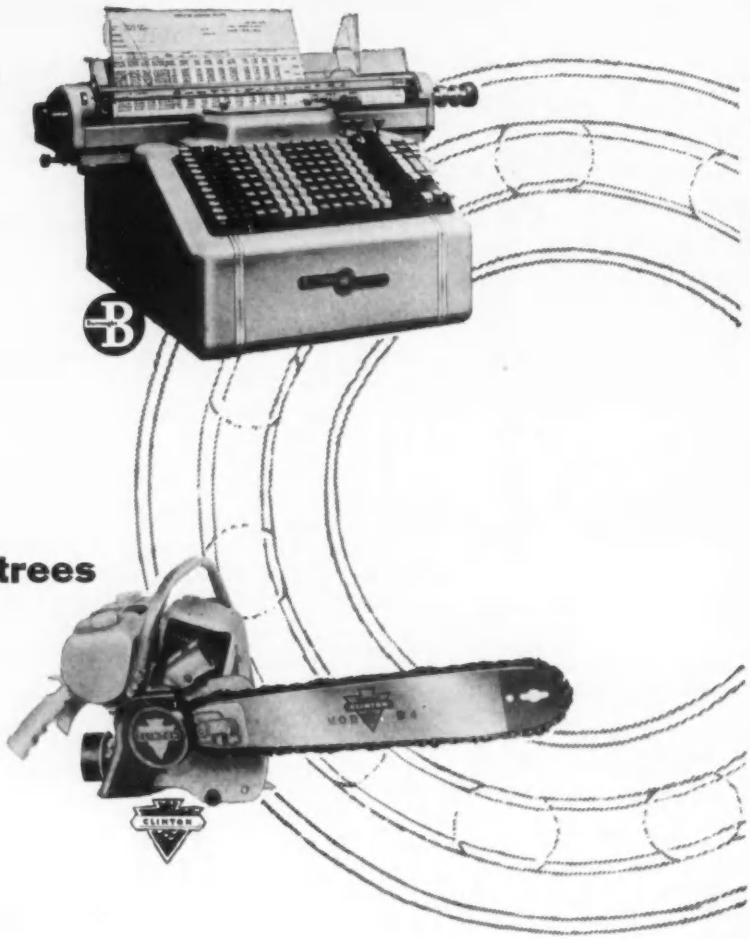
105

PROCESS GEAR CO., INC.

4602 W. Fullerton • Chicago 39, Illinois

cutting through accounting costs...

Push a few buttons and the "mechanical brain" of the Burroughs Sensimatic takes over, posting records with amazing speed and accuracy. Smooth, quiet operation is of vital importance. Federal Ball Bearings are used here, too.



...or cutting down trees

Any woodsman becomes a Paul Bunyon with a Clinton Chain Saw. These rugged tools send timber toppling at a furious rate. They've got to be tough—and that goes double for the ball bearings. Clinton specifies Federals.

so much of industry *turns* on FEDERAL ball bearings

Deep in the nation's timberland...high in a skyscraper office building—wherever there's work to be done, you'll find labor saving, time-saving machines. And wherever you find machines, you'll find Federal Ball Bearings, in every size and description, making their vital contribution toward smooth, trouble-free performance. There are 12,000 sizes of Federal Ball Bearings to solve your anti-friction problems. Hundreds of types. Produced by a 50-year-old manufacturer of ball bearings exclusively.

When Federal Ball Bearings are part of so many things you *use*, shouldn't they be part of the things you *make?*

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, N. Y.

New! Ball Bearing and engineering data! 175 pages full in FEDERAL'S NEW CATALOG! To get your copy, just drop us a line.

Federal Ball Bearings *One of America's Largest Ball Bearing Manufacturers*

More POWER with Less Amps!

Century Performance-Rated® FAN MOTORS

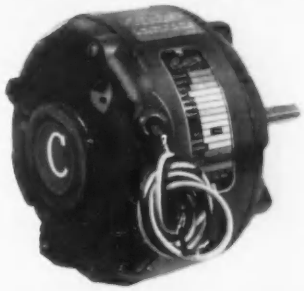
HELP SOLVE YOUR LOAD AND POWER FACTOR PROBLEMS

In air conditioning or ventilating equipment, you can reduce starting current, reduce running current and increase power factor with these new Century Fan Motors. They are Performance-Rated for air conditioning manufacturers who are faced with new load and power factor problems. Fan manufacturers find advantages in their short length, light weight, multi-speeds and easy reversibility.

In your product and in your plant, Century Motors are Performance-Rated to fit your needs. For information, call your nearby Century Sales Office, or write us direct.

Type C, Permanent Split Capacitor . . . round frame, single speed, reversible—also available with cushion mounting.

Type CM, Permanent Split Capacitor . . . round frame, 2 or 3 speeds, all reversible—also available with cushion mounting.



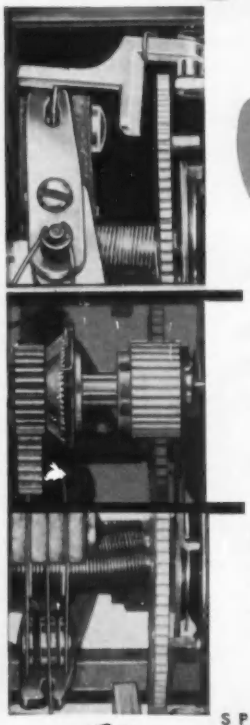
CE-75

Performance-Rated®
1/8 to 400 H. P.

CENTURY ELECTRIC COMPANY

1806 Pine St., St. Louis 3, Mo. • *Offices and Stock Points in Principal Cities*

NEW!



CRAMER

automatic reset
INTERVAL TIMER

NEW—Full-vision 300° protected dial for fast, accurate readings.

NEW—Large friction setting knob with integral push button.

NEW—Repeat accuracy within ±½ of 1% of full scale.

NEW—15-amp. open-blade switches, positive quick-make, quick-break operation.

NEW—Multi-position terminal block offers wiring flexibility, side or rear connection.

Powered by the high-torque (30 in. oz. @ 1 r.p.m.) Cramer synchronous motor, the Type 241 Automatic Reset Interval Timer has been designed and tested to new standards for *maintained* accuracy over a long service life. Available in ranges from 15 seconds through 24 hours. Write for complete information.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 7, CENTERBROOK, CONNECTICUT

forced plastic combinations. We know of one epoxy resin glass reinforced structure which sustained a level of 26,000 psi for 6 mo, at the end of which, subsequent tests indicated less than 5 per cent over-all loss. Out of hundreds of resins of all types now available, only 5 or 6 are capable of withstanding stress levels representing 35 per cent of the potential glass cage strength, and only one resin capable of 60 per cent of the same value. The vast majority of resins will safely sustain less than 15 to 20 per cent of the potential glass cage strength, and the seven which exceed that level are all epoxies. The foregoing values are based on a structure containing 55 per cent glass by weight and room temperature conditions. Temperatures of 180 F make the picture much blacker indeed.

Role of Technological Institutions in the Years Ahead

Abstracted from "Role of Technological Institutions in the Years Ahead," by John T. Rettaliata, Pres., Illinois Institute of Technology, Chicago, Ill., *Mechanical Engineering*, March 1956.

Technological education, in common with education generally, has many problems, and in the solution of these problems it must have help if it is to continue in its role of mankind's benefactor.

However, private education's major problem is its financial situation. A study conducted by the *New York Times* emphasizes the financial dilemma of most educational institutions. The survey of 810 institutions of higher learning revealed that almost one half of the private ones are unable to balance their budgets. The future existence of some of these institutions is being seriously threatened as costs continue to mount.

Obtaining additional income through contributions appears to be the most feasible method for solving the grave proble mthat exists. Such contributions resolve into the categories of alumni, foundation, individual, and corporate support. Since, under our present tax structure, the wealthy individual is rapidly becoming extinct, the colleges and universities must rely principally on the remaining three

(Continued on page 364)

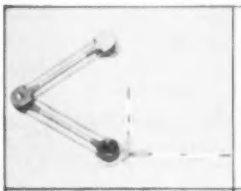
FROM BRUNING – Your One Convenient Source for All Drafting Needs...

5 "Thrifty Nifties"

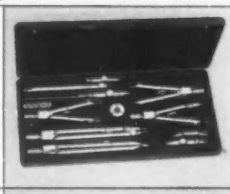
That Will Save You Time, Work, and Money!

Little things mean a lot in drafting! That's why the five outstanding, low-cost drafting aids featured here are important to you. That's why they and many products like them are important members of Bruning's complete quality line. Try them; you'll be mighty pleased at how fast the savings of time and labor mount up!

BRUNING ELECTRIC ERASING MACHINE
Save hours of finger-cramping manual erasing. Do a neater, safer erasing job. The patented hollow shaft permits use of extra-long, seven-inch eraser, prevents "fly-outs". These quiet, cool, vibration-free tools are permanently lubricated, require no maintenance.



BRUNING VARSITY DRAFTER
Costs a few dollars more than conventional T-Square, triangle, and protractor; lets you make neater, more accurate drawings . . . up to 25% faster. Full circle protractor and indexing clamp permit scales to be set quickly and precisely to any desired angle. For drawings to 24"x30". Ideal for shop drawings, home use, students.



WILD STAINLESS STEEL INSTRUMENTS
Now, get the higher precision, lifetime durability and beauty offered only by the instruments made entirely of stainless steel. They will not oxidize, can not be damaged by perspiration. Specially hardened, swivel-type pen nibs are exceptionally durable, easy to clean. Swiss precision-made. Moderately priced. Handsome metal cases.

PHENOLIC BLADE T-SQUARE
Get the lasting trueness, durability, and beauty of modern plastics in this moderate-priced T-square. The warp-proof, practically indestructible blade is made of laminated phenolic plastic, with a life-like maple finish. Drawing edges of crystal clear acrylic plastic are relieved for easy, safe ruling with ink; will not discolor or become brittle.

No. 697 CROSS SECTION PAD
This handy, time-saving cross section pad lets you draw to scale...make sharp copies without cross section lines. Cross section lines are printed in light blue, will not reproduce. Pads are available with or without pre-printed heading containing fill-in blanks for basic data. Cross sections come 4x4, 5x5, 8x8, 10x10 squares per inch.

Take a minute now to mail the coupon. Save yourself hours of time and work later on.

BRUNING

America's Leading Supplier of Engineering and Drafting Equipment.

CHARLES BRUNING COMPANY, INC., 4700 MONTROSE AVE., CHICAGO 41, ILL.
In Canada: Charles Bruning Company (Canada) Ltd., 105 Church Street, Toronto 1, Ontario

Charles Bruning Company, Inc., Dept. 64-0
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on these Time-and-Work Savers:

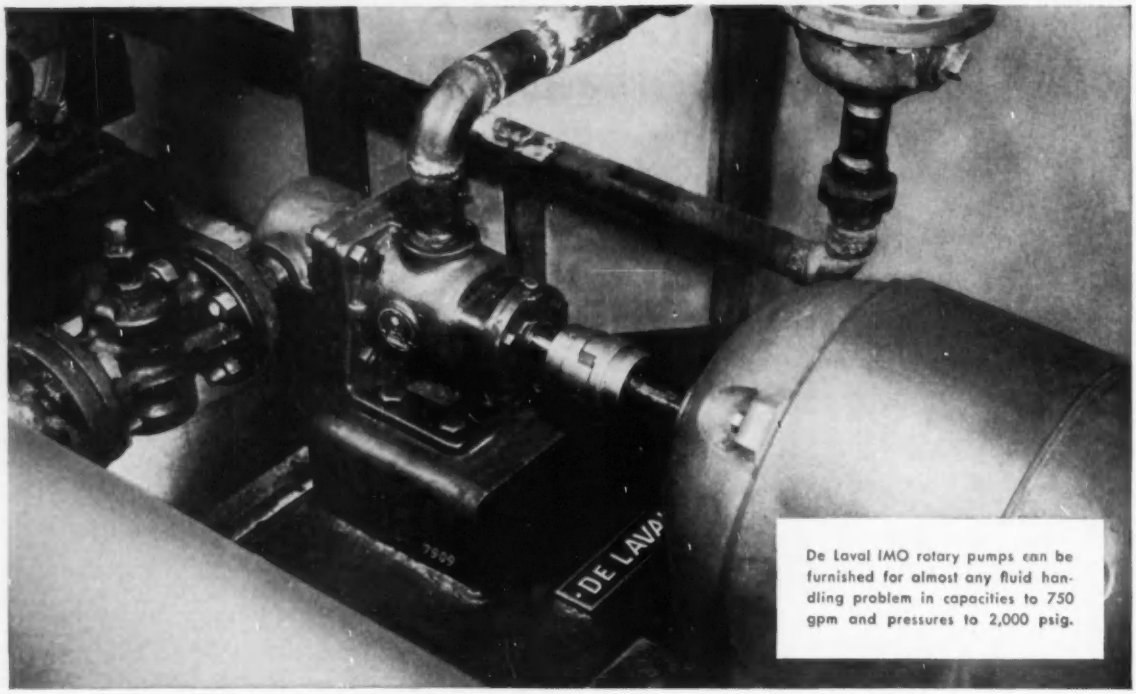
☐ Electric Erasing Machine ☐ Varsity Drafter ☐ Wild Instruments
☐ Phenolic T-Square ☐ Cross Section Pad

Name_____ Title_____

Company_____

Address_____

City_____ County_____ State_____



De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 2,000 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

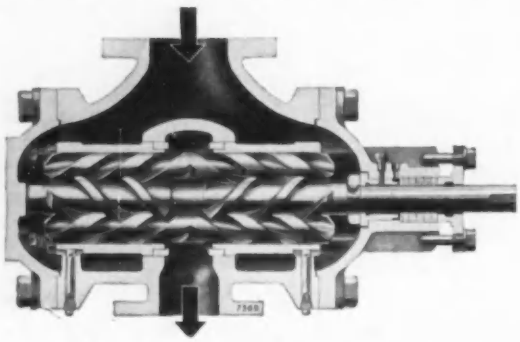
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

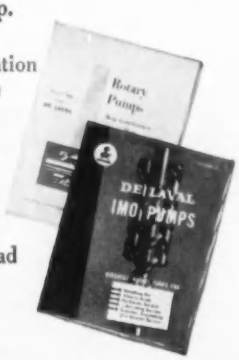
One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



This is a cross-section of the De Laval IMO Series A322A, a positive displacement rotary screw type pump.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 801, Nottingham Way, Trenton 2, New Jersey. DL-301



NOELTING

For Longer Life Specify **Faultless**

DOUBLE TREAD STEEL WHEELS

They Resist Sharp Shocks and Jolts... Carry Twice the Load of Cast Wheels

To solve your breakdown problems Faultless developed this Drawn Steel Wheel.

With sturdy double-steel flat tread, it defies the punishment of sudden jolts. Chip-proof rounded edges are precision-made to roll smoothly and evenly—without fracturing—on any kind of floor.

Added strength and durability are provided by corrugated steel sides and a strong hub bearing, protected by mighty built-in steel shoulders. This wheel is absolutely concentric for smooth, effortless operation.

And it cuts into handling costs by reducing replacement labor.

DRAWN STEEL WHEEL—available in 4", 5" and 6" sizes, double ball bearing

100 SERIES—Light duty, single ball race swivel for general use.

200 SERIES—Rigid type, companion to 100 Series.

900 SERIES—Heavy, corrugated steel, double ball bearing.

1100 SERIES—Light duty, dust proof double ball bearing swivel plate.

600 SERIES—Heavy duty, special alloy rollers, brass

300 SERIES—Medium duty, pressed steel plate, very strong.

1700 SERIES—Rigid type, companion to 1100 Series.

500 SERIES—Rigid type, companion to 600 Series.

AVAILABLE IN LIGHT, MEDIUM and HEAVY DUTY CASTERS

It's easy to select just the right Drawn Steel Wheel Caster for your equipment.

Capable of supporting operating loads of 2,000 lbs. per wheel (or static loads of 8,000 lbs. per wheel), Faultless Drawn Steel Wheels may now be had for light, medium or heavy duty requirements.

In addition to 8 types of Swivel Plate Casters with Drawn Steel Wheels, companion Rigid Plate Casters are available.

Let your Faultless Caster representative help you choose the right Caster for your needs, or write us for Catalog specifications, no obligation.

FAULTLESS CASTER CORPORATION, EVANSVILLE 7, INDIANA • Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, Portland, Seattle, St. Louis. Canada: Stratford, Ontario

When product designs for welded steel

Have twice the rigidty... three times the strength

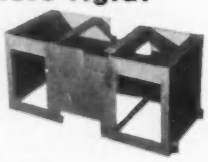
Yet require less material ...cost less to fabricate

WHY

aren't all your products designed for welding?

THE BETTER WAY
40% more rigid!

. . . yet this machine base of welded steel costs half as much as former cast iron designs.



Ask
THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
The World's Largest Manufacturer of Arc Welding Equipment

sources. Of these, corporate support possesses the greatest potential.

The colleges and universities feel that their mission is worthy, and that they can continue to make important contributions to the progress and security of the nation by providing a continuing supply of adequately educated manpower. They desire, therefore, that aid rendered them not be regarded as charity, but rather as a "factory expense," a legitimate cost of doing business.

And the incentive for assistance is compelling for, as has been stated by the Council for Financial Aid to Education, "what happens to American education will eventually happen to America."

The Engineer's Greatest Achievement

Abstracted from "The Engineer's Greatest Achievement," by Crosby Field, Pres., Flakice Corp., Brooklyn, N. Y., March 1956, *Mechanical Engineering*.

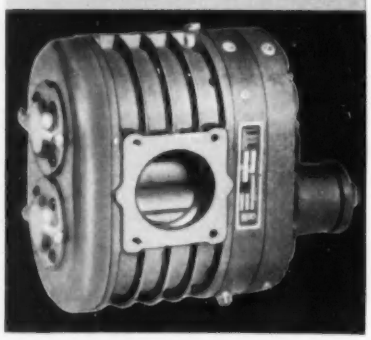
The works of the engineer have become so widespread in this western world in which we live, that rightfully we may call it the engineer world. Great as may be these works, yet the engineer's greatest achievement is the absence from the commerce of the engineer world of trade in human slaves. This is indeed the greatest achievement of the engineer in commerce and industry; the removal of the need for human slavery is in fact his great contribution to the world. How has he accomplished this? By the substitution of cheaper mechanical power for the apparently cheap but relatively more expensive muscle power of the slave.

In the pre-engineer world, former or present day, stronger nations found that slaves were not only very useful but were essential to improve the standard of living of the masters; and most nations made war for the purpose of securing slaves. "The nation which could not, or would not, defend itself soon ceased to exist, and its people became slaves. The life of a slave was generally worse than dead."

The presence of slaves brutalized the household of the master; punishment dungeons or rooms existed in every large house; the smaller homes made use of the public jailers who were also expert floggers. In these

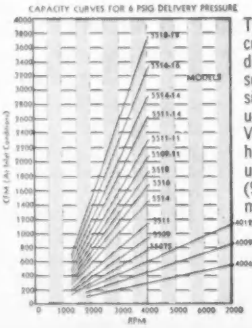
(Continued on page 368)

How Miehle-Dexter Blowers supply air for your product



PROBLEM: Design any product requiring a blower—up to 14 psig. of air (or gas). Do not increase size, weight or cost of product.

SOLUTION: Only Miehle-Dexter Blowers solve this problem. Exclusive 3-lobe construction provides maximum air in minimum size blower. Units require little or no maintenance. Hundreds of applications. Now used as powerful new jet engine starters in mobile ground power equipment. Used for pneumatic conveying, agitation, aeration cooling, ventilating, supercharging. For more facts, write for new Bulletin 255.



Typical capacity curve for 6 psig. delivery pressure. Standard sizes available up to 4000 cfm. Vacuum to 15" hg. Pressures up to 14 psig. (90 psig. by multi-staging.)

MIEHLE | **DEXTER**
Supercharger Division
Dexter Folder Company
116 Fourth St., Racine, Wisconsin

WE CREATE AND MAKE

For a hundred years . . . for hundreds of people . . . we have developed and produced custom-made *specialty papers* to do special jobs.

Perhaps you, too, could use paper in place of other material . . . to make *your* products better, for less!

We *create* . . . in our research and development laboratories . . . specialty papers to meet most any requirement of wet or dry strength, lateral or longitudinal strength, absorbency, porosity, or any combination of these factors.

And we *make* . . . on modern machinery, and with rigid quality control . . . any quantity needed of these specialty papers.

We offer you our research facilities. Perhaps we can help you make *your* product better, for less . . . with a custom-made paper!

Call or write us, any time.

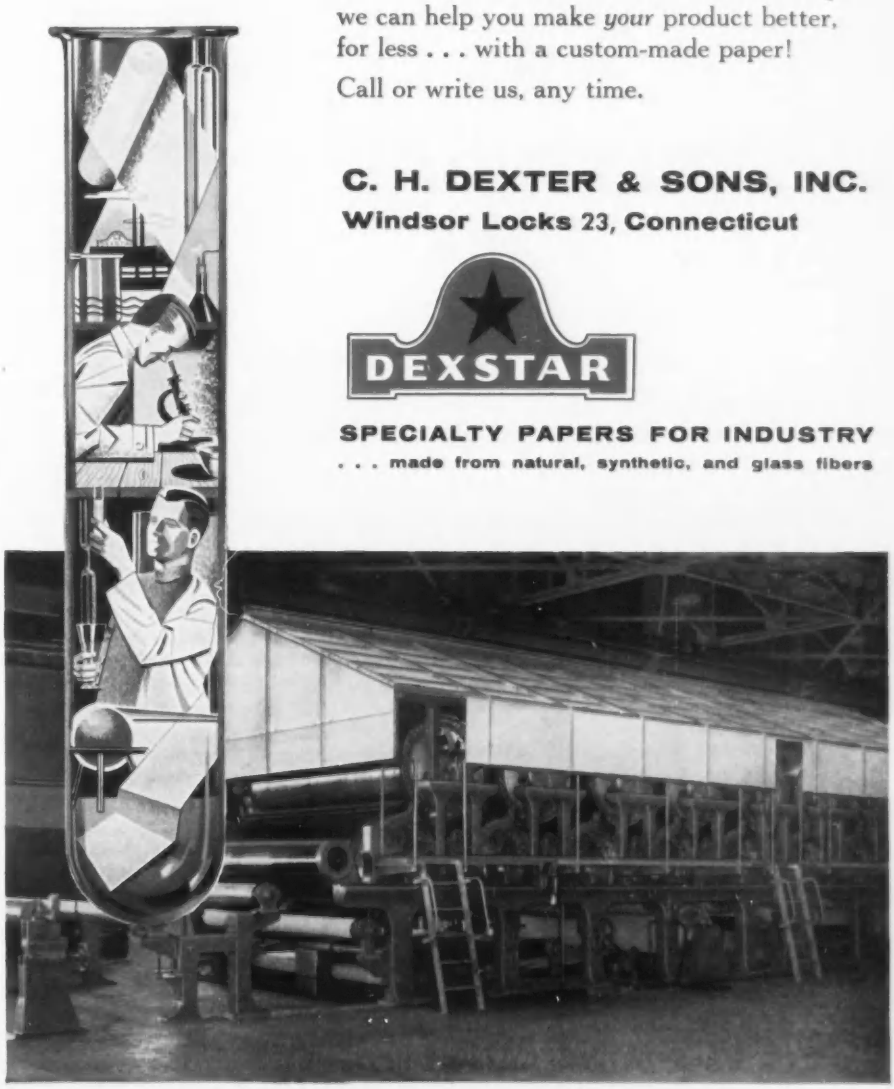
C. H. DEXTER & SONS, INC.
Windsor Locks 23, Connecticut

DEXSTAR

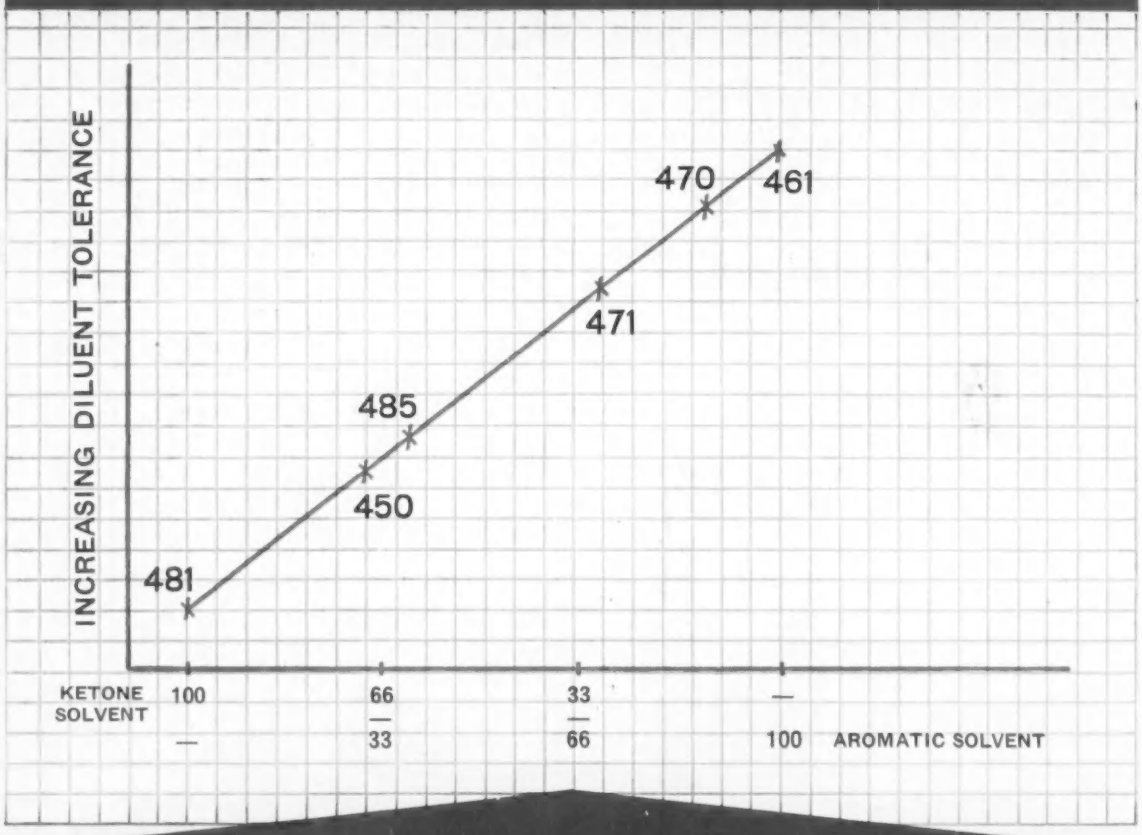
SPECIALTY PAPERS FOR INDUSTRY
. . . made from natural, synthetic, and glass fibers

DEXSTAR
SPECIALTY PAPERS

in tea bags
in oil filters
in hair wave kits
in electrolytic capacitors
in vacuum cleaners
in air conditioners
in hi-temp electrical insulation
in disposable diapers
in wallboard tape
in hospital face masks
in coolant filters
in sachets
in duplicating stencils
in coffee filters
in flat silver wrapping
in edible oil filters
in cheese processing
in dry-cleaning tags
in lens tissues
in chamois-like wipers
in yarn dying covers
in plastic laminations



EXON SOLUTION RESINS—VINYL CHLORIDE TYPE



Pick your proper solution resin...*at a glance!*

• Another Firestone service to help you make the right resin choice!

These 6 EXON solution resins are engineered precisely, varying in properties to suit various applications and uses—but never varying in quality of performance.

Further product details at right. Keep this chart handy to help you choose easily and accurately.

EXON 450 — Ideal for strip coatings. Good solubility, tensile strength and durability.

EXON 461 — A unique fluorine-containing resin combining high solubility, unusual chemical resistance, heat stability and weatherability.

EXON 470 — Excellent adhesion to metals, alkyd and vinyl surfaces. Compatible with wide range of drying oils, alkyds, phenolics, melamines. High solubility in inexpensive solvents.

EXON 471 — Excellent for weatherability and durability in a protective coating. Corrosion resistant. No measurable change after sunlamp exposure for 360 hours as 1 mil film.

EXON 481 — Makes possible colorful, abrasion-proof, washable coatings that resist fading or cracking.

EXON 485—For superior strip coatings. Lower viscosity makes application easier and shelf-life better. Good clarity.

Firestone

EXON®

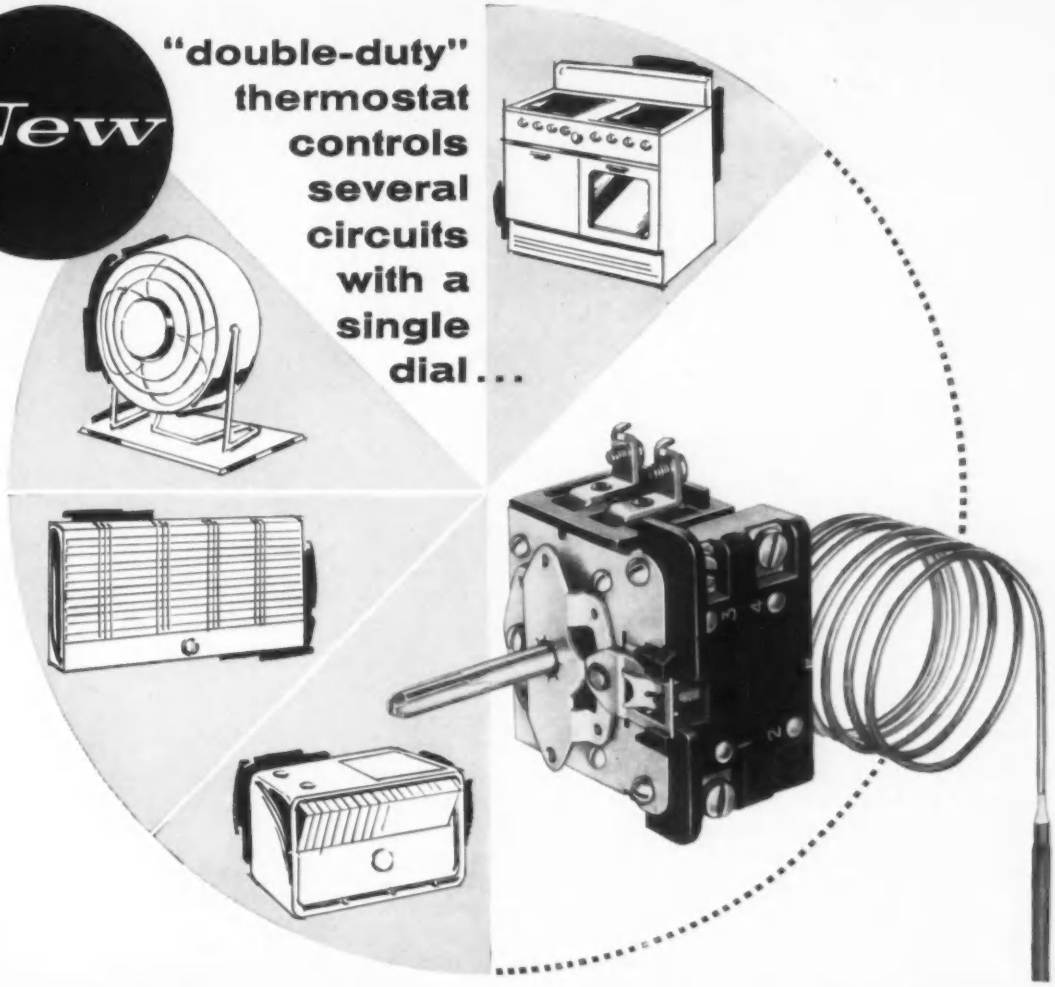
For complete information and technical service, call or write:

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY, DEPT. 66H, POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE AND RUBBER COMPANY

New

"double-duty" thermostat controls several circuits with a single dial...



the Wilcolator Series GA

COMBINATION THERMOSTAT AND SWITCH

The special feature of this new thermostat, used for both heating and cooling applications, is the switch, which is cam-operated from the dial shaft. This switch makes it possible to control more than one circuit with a single dial, and to disconnect more than one line when the dial is turned "OFF".

For instance, Type G1-A (heater load) can control both "bake" and "broil" circuits for an electric range, and incorporate double pole break in the "OFF" position. And in an air-conditioner, Type G2-A provides for "constant cool", "fan only", and "fan and cooling" from a single dial shaft.

Amplitude can be factory adjusted to customer's specifications. Contact mechanism is not affected by vibration. For full information on the Series GA, contact The Wilcolator Co., 1001 Newark Avenue, Elizabeth, N. J. Canadian plant: Wilcolator (Canada) Ltd. Mimico, Toronto, Canada.

SPECIFICATIONS:

Standard temperature range: 40°F Minimum, 550°F Maximum

Special temperature ranges: to customer's requirements.

Type G1-A: Contacts open on temperature rise.

Type G2-A: Contacts close on temperature rise.

Contact Rating: Type G1-A, 30 Amp. 125 and 250 volts—AC non-inductive load.

Motor Ratings: Type G2-A.

VOLTS	RUNNING CURRENT	LOCKED ROTOR
120 AC	14 AMP	60 AMP
208 AC	14 AMP	60 AMP
240 AC	14 AMP	60 AMP

Both motor and non-inductive ratings Underwriters listed and approved.

Mounting: Back of panel or in enclosure.

Terminals: Screw Type, AMP or Arkles. Standard shaft size—¼" flatted to .156". Length to customer's specifications.

THE Wilcolator COMPANY

New PLAN-GEAR TRANSMISSION

as simple to operate as an Electric Motor

• Here is AMERICAN GEAR'S new **PGT** transmission as used with a Chrysler engine to power a gasoline tractor. This new, hydraulically operated compound planetary transmission has been successfully used on earth movers, road rollers, tractor loaders and other equipment.

• Complete performance tests at one of the country's leading Institutes of Technology have verified **PGT's** outstanding performance. The report on these tests describes **PGT** as "offering a simple, versatile and extremely flexible means of power transmission...good efficiency ...conservatively rated."*

• **PGT** offers these important advantages over more complex transmissions...

- Easily operated by anyone by merely moving a single hydraulic control lever
- Practically instantaneous (1.5 seconds) change of speed or direction without shifting gears
- Only one control valve lever for all speeds and neutral
- Utterly smooth...no shock...no jerk...no noise
- Cushion shift prevents shock loading, eliminates trouble
- Eliminates operator fatigue by eliminating clutch pedal
- Hydraulic control lever placed convenient to operator without regard to location of transmission
- Planetary gearing means considerably less length for comparable loads and speeds
- Positive pressure-fed lubrication to bearings and gears
- Two power take-off apertures can transmit up to one-third of engine output maximum

**Complete report on request*

Write today for this new 8-page booklet which gives complete information, design details on all 7 models of PGT transmissions

7 DIFFERENT MODELS • 85 OR 150 TO 200 LB. FT. TORQUE
1 OR 2 SPEEDS FORWARD • CHOICE OF REVERSE RATIOS

USE PGT TRANSMISSION ON
Lift trucks • Earth movers • Hoists and cranes • Car pullers • Slushers
Conveyors • Power take-offs • Front end loaders • Road rollers
Other industrial equipment • Truck mixers

Designed and built exclusively by

AMERICAN GEAR & MFG. CO.
New Avenue, Lemont, Illinois • Phone: Lemont 920

Subsidiary of BRAD FOOTE GEAR WORKS, INC., Cicero 50, Illinois

rooms existed torture devices, of which the lash was the least. The whip was used not only on the slave, but on the children, and frequently on the wife. The difference in mental attitude toward all persons between a slave-holding society and a free society is even greater than the difference in their standard of living.

The world has found that the breeding and use of mechanical power-driven metal slaves has become the basis of all engineer-world commerce and industry, just as human slaves were and are the basis of all pre-engineer civilizations.

Although many figures have been given, yet they may all be summarized by saying that in the pre-engineer civilizations the average number of human slaves per free man varied from one to ten, every American today has the equivalent on an energy basis of 260.

When our showdown comes with the slave empires of today, can our metal slaves made and operated by free men win the victory against the engineer's metal slaves made and operated by slaves? Our generation may witness the answer. The answer is, I believe, that we will, provided we ourselves do not become victims of slavery in one of its hidden forms. Let us not forget, the engineer by himself does not abolish slavery; his great contribution is that he removes the need for slavery.

Why Register

Abstracted from "Why Register," by Paul H. Robbins, Executive Director National Society of Professional Engineers, presented at Twenty-Fourth Annual Meeting, American Society of Tool Engineers, Chicago, Ill., March 19-23, 1956.

Legal registration of members of a profession is an exercise of the police powers inherent in every state for protection of the public health and public safety. Such registration gives assurance that only those persons who meet fixed educational and experience requirements may practice engineering.

Uniformity is difficult to obtain because each state is rightfully an independent commonwealth and has a right to establish its own police power regulations. To obtain a measure of uniformity, however, engineering practitioners have developed a "model

(Continued on page 372)

Richardson design and molding service..

Reduces Unit Cost From 75¢ to 11¢!

BEFORE 75¢

The problem: This is a metal tray . . for taking dental impressions. Because trays of this type were relatively expensive (75¢ each), dentists found it necessary to clean and re-use them. In spite of careful cleaning, the trays would corrode, oxidize, discolor and, after repeated use, become generally unattractive.

What was done about it: The Wm. Getz Corp., Chicago, asked Richardson to recommend a material and design a new plastic dental tray. Richardson engineers suggested a clear polystyrene material and designed and constructed, for economical production, this complicated 10-cavity mold weighing 2322 pounds.

AFTER 11¢

The result: This plastic dental tray is more sterile and has much better eye-appeal. It costs only 11¢ instead of 75¢ . . a savings of 85% which permits the dentist to discard each tray after it has been used. Tedious time-consuming cleaning of old metal trays is no longer necessary.

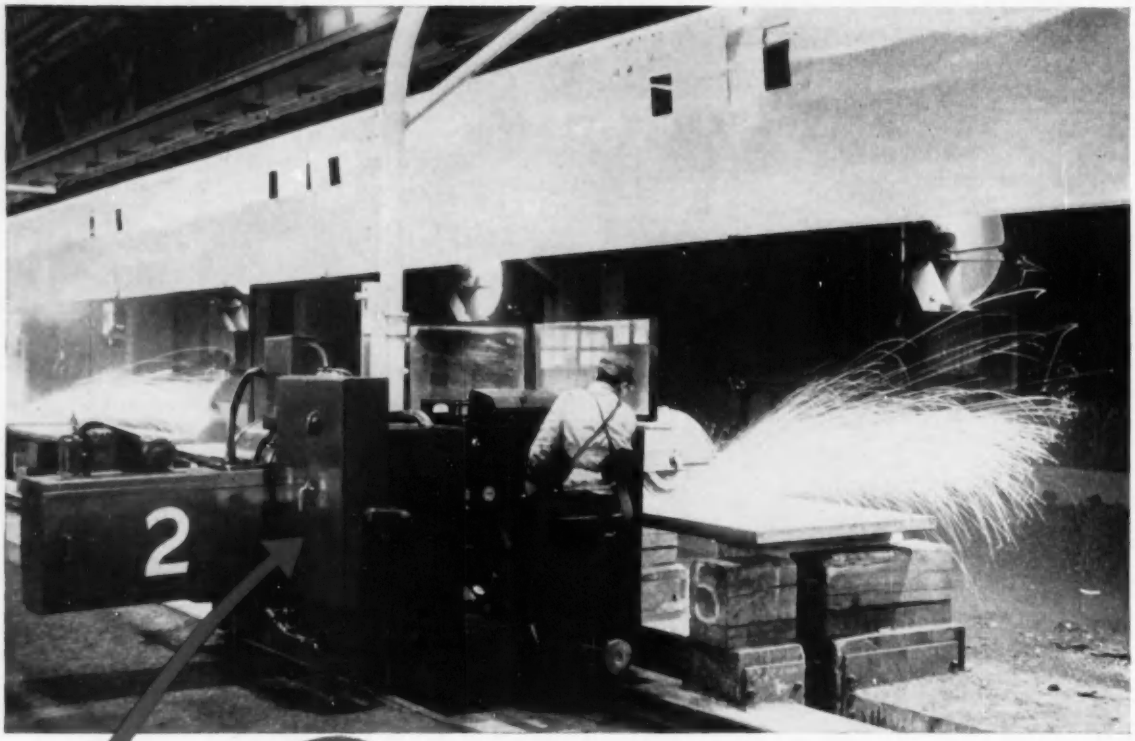
Are you redesigning your product for better sales-appeal? Richardson engineers, consulting with your own engineers, can help in the development of design changes for better performance, improved appearance, and lower production cost. Complete laboratory facilities are available for the development of special plastic materials for your applications. Experienced Richardson tool and diemakers can produce your molds for efficient parts molding.

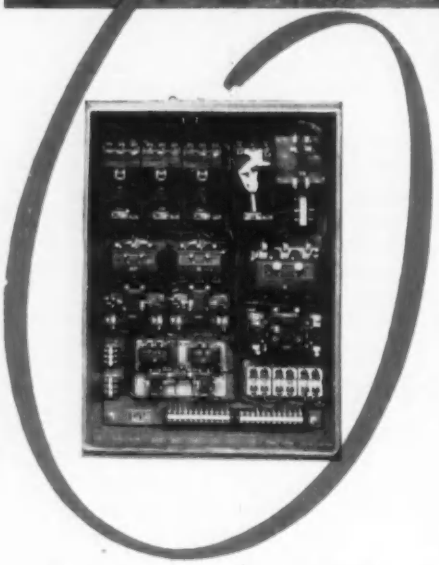
For detailed information write or phone The Richardson Company. 2793 Lake St., Melrose Park, Illinois (Chicago area)

RICHARDSON PLASTICS

laminated and molded

MELROSE PARK, ILL. | INDIANAPOLIS, IND. | NEW BRUNSWICK, N. J. | NEWNAN, GA. | OGDEN, UTAH | TYLER, TEXAS





Clark Type "CY" Control Panel mounted on each machine contains a size 0 reversing, two size 2 and one size 3 Type "CY" motor starters.

CLARK Type "CY" CONTROLS

help Mid-West Slab Grinders triple output at Crucible Steel!

Ten track mounted billet grinders built by the Allied Machine and Engineering Co., a subsidiary of Mid-West Abrasive Company, are setting new performance standards at Crucible Steel's Midland, Pa. mill. Replacing manually operated and unwieldy swing grinders, these machines do the job better, faster and safer with electrically-controlled hydraulic positioning.

Accurate and complete control of stroke, wheel position, rotation and pressure results in smaller metal loss, less wear on grinding wheels and better finish. Clark Controls provide the accuracy and dependability these machines require, and prove again that Clark Type "CY" starters have the extra stamina required for heavy-duty mill-type service.

The CLARK CONTROLLER Company

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

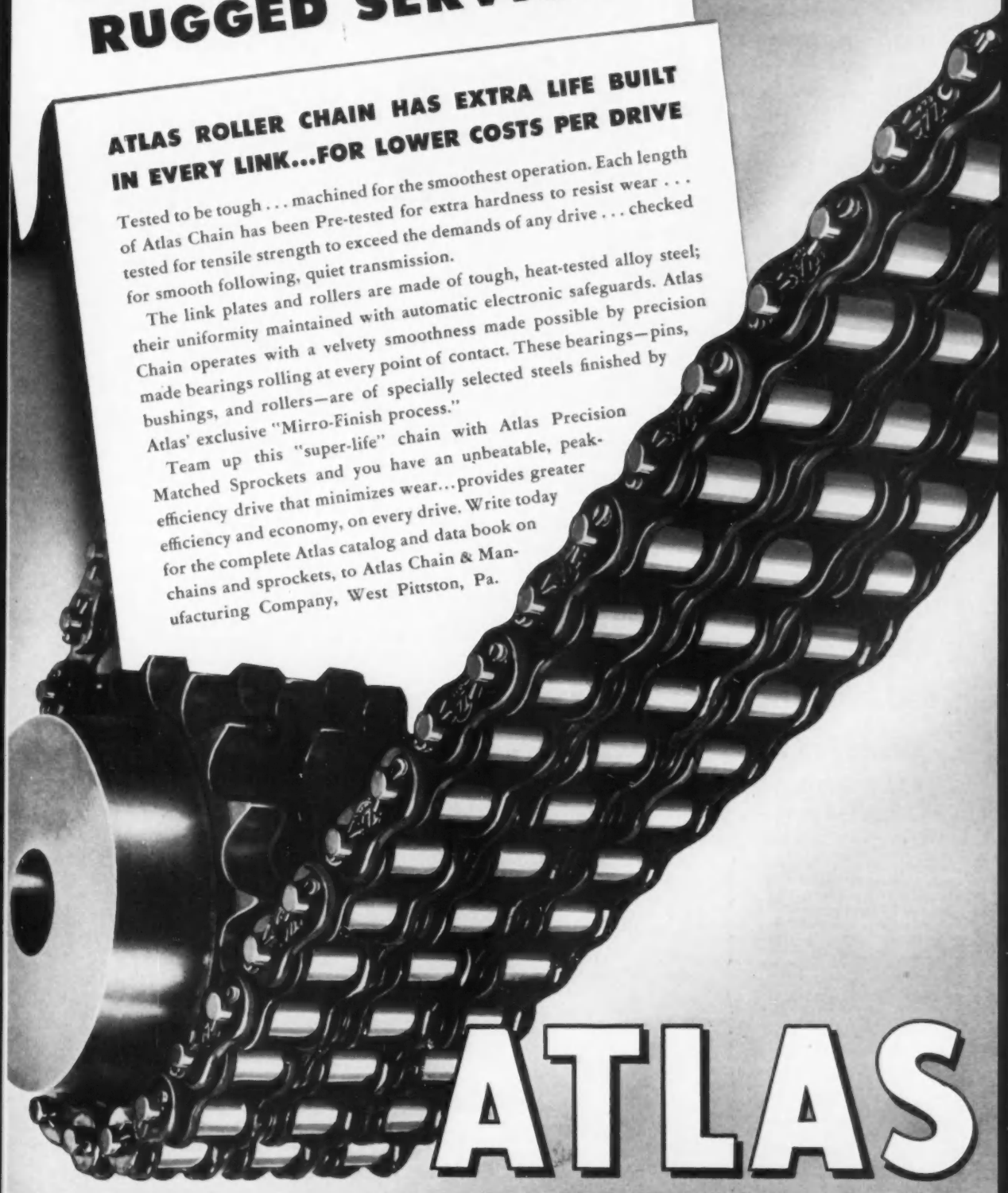
PRODUCTION-PROVED FOR RUGGED SERVICE

ATLAS ROLLER CHAIN HAS EXTRA LIFE BUILT IN EVERY LINK...FOR LOWER COSTS PER DRIVE

Tested to be tough . . . machined for the smoothest operation. Each length of Atlas Chain has been Pre-tested for extra hardness to resist wear . . . tested for tensile strength to exceed the demands of any drive . . . checked for smooth following, quiet transmission.

The link plates and rollers are made of tough, heat-tested alloy steel; their uniformity maintained with automatic electronic safeguards. Atlas Chain operates with a velvety smoothness made possible by precision made bearings rolling at every point of contact. These bearings—pins, bushings, and rollers—are of specially selected steels finished by Atlas' exclusive "Mirro-Finish process."

Team up this "super-life" chain with Atlas Precision Matched Sprockets and you have an unbeatable, peak-efficiency drive that minimizes wear...provides greater efficiency and economy, on every drive. Write today for the complete Atlas catalog and data book on chains and sprockets, to Atlas Chain & Manufacturing Company, West Pittston, Pa.



ATLAS

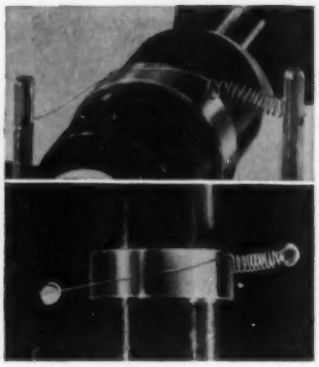
ROLLER CHAIN AND SPROCKETS

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

SLIP RING PICKOFF

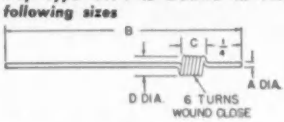
developed by

NEY



A new concept of slip ring brush design has shown life better than 100 million revolutions at low electrical noise level. A self-contained spring and wire contacts slip ring over a sector of approximately 180°. Size of wire used in tests, .004-.006 diam., with wear at end of 100 million revolution test less than one-half diameter. Write for information.

Ney Type 1194 is stocked in the following sizes



	A dia.	B	C	D
1194-1	.004	1.5	.024	.040
1194-2	.006	2.0	.036	.060
1194-3	.008	3.0	.048	.080
1194-4	.010	3.0	.060	.100

THE J. M. NEY COMPANY P.O. BOX 990 DEPT. J
HARTFORD 1, CONNECTICUT

Specialists in Precious Metal Metallurgy since 1812

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

testing components and complete packages to MIL 5272A?

Read what a user says about Genisco G-Accelerators!

United States Gauge, Sellersville, Pa., recently purchased a Genisco Model B78 G-Accelerator to assist in the development and testing of new instruments. Gauges from 1" size for hydraulic and accumulator applications, to pressure transducers for guided missiles have been tested under acceleration forces up to 75 g's.

Commenting on the performance of the machine, a U.S. Gauge engineer said: "Particularly useful are the rotating pressure ports (air system) and slip rings. In my opinion, the Genisco Model B G-Accelerator is a well-designed piece of equipment, easy to set up and operate, and has required only minor maintenance."

If you need to subject components to simulated g-forces, or to calibrate and evaluate accelerometers, contact your Genisco representative for complete information on Genisco G-Accelerators.

NOW FOUR STANDARD MODELS

MODEL NUMBER	G-RANGE	CAPACITY	RADIUS OF GYRATION
B78	30 to 120	25 lbs.—8" cube	24"
C159	30 to 75	100 lbs.—18" cube	44"
D184	1 to 800	6 1-lb. objects	12"
E185	0.01 to 60	300 lbs.—30" cube	72"

Genisco INCORPORATED

2233 Federal Avenue
Los Angeles 64, California

Reliability first

law" which has been used as a guide for thirty years. That law has been revised and brought up to date repeatedly since first drafted, the most recent edition having been made in 1946 and bearing the approval of thirteen national engineering societies. Even if complete uniformity of laws could be obtained, differences in interpretation and administrative procedure that exist among the state boards charged with their administration would probably bar exact likeness in operation of engineering registration from one state to the next. Uniformity, which will permit wider reciprocity, is a goal toward which engineering organizations —and the members of the registration board through their national organization—are toiling.

By going through the registration process, which is both simple and inexpensive, an engineer gains two important benefits:

1. He receives authority to practice his profession before the public.

2. He establishes his professional standing on the basis of legal requirements.

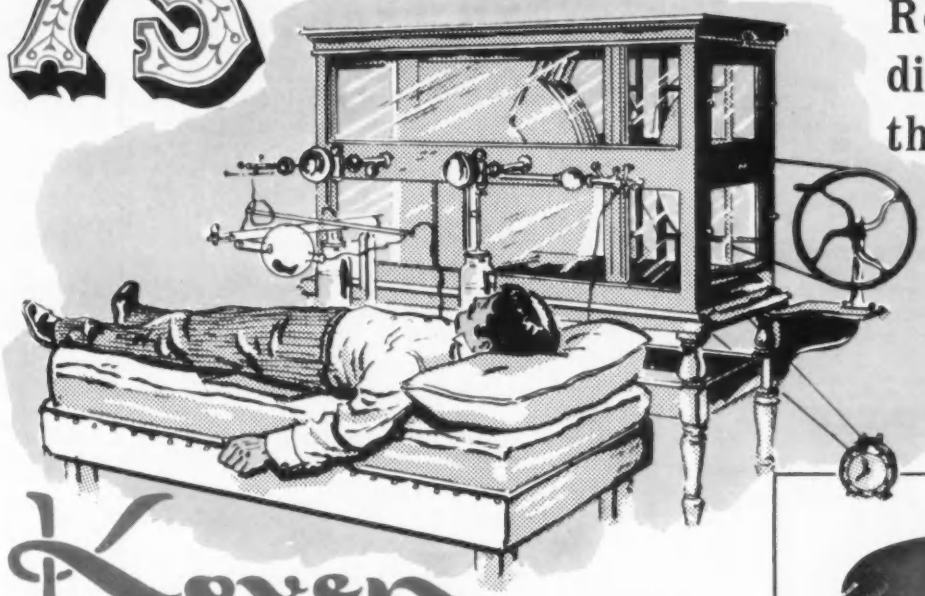
In addition to the two points cited above there are additional considerations of real importance.

An engineer in employment not requiring registration has no assurance that he will always be in that position. Many engineers have moved from employment into engineering practice for the public and have found their way handicapped by failure to obtain registration at an earlier date. The time to register is just as soon as you can, then you will not have the difficulty of seeking registration long after your academic training has ended.

Other engineers have found instances where their registration has been helpful in engineering activities associated with their work, even though their main work did not require it; for example, in establishing their competence to testify in legal cases. In a recent court case, the court ruled against the testimony of an expert witness in a patent case because the individual, while claiming to be an engineer, was not registered!

COMING IN JULY—A 16-page special report on "Functional Design of Hydraulic Circuits," to aid in component and circuit selection.

75 years ago and 14 years before Roentgen discovered the x-ray



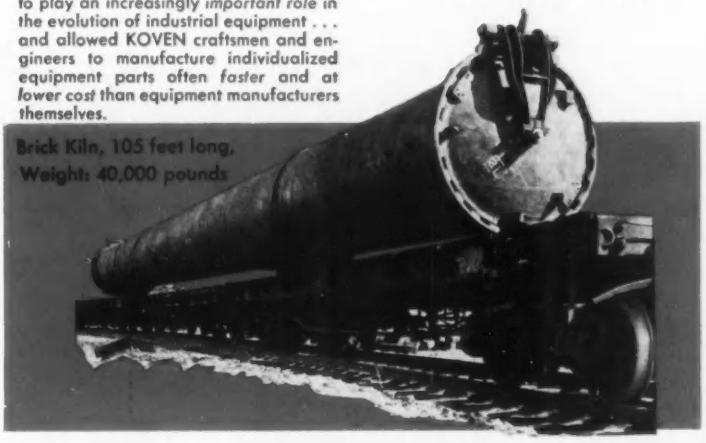
Koven was making individualized equipment parts

Intelligence—initiative—perseverance—*these* are the ingredients of success. Mixed often enough and in the proper proportions, they beget progress—the essential element in the overall development of science and industry alike.

Add a pinch of experience (75 years worth to be exact) to the above ingredients and you have the KOVEN formula for success: the time-tested skill and research, the seasoned craftsmanship and technique, which have enabled KOVEN to play an increasingly *important role* in the evolution of industrial equipment . . . and allowed KOVEN craftsmen and engineers to manufacture individualized equipment parts often *faster* and at *lower cost* than equipment manufacturers themselves.

For individualized equipment parts built *efficiently* and *economically* to your *exact* specifications, call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550. There's no obligation.

Stainless Clad Jacketed Tank



Brick Kiln, 105 feet long. Weight: 40,000 pounds

X-RAY INSPECTION FOR QUALITY CONTROL

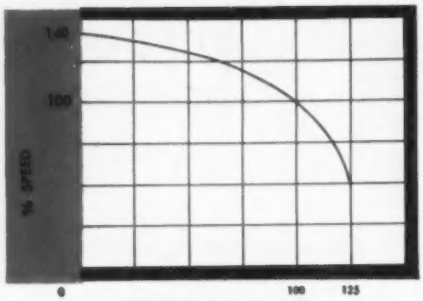
KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.

SPECIALISTS IN INTRICATE FABRICATION USING:
• STAINLESS STEEL • ALUMINUM • MONEL • NICKEL • INCONEL
• ALL CLAD MATERIALS Fabrication to all A.S.M.E. Codes

Koven *FOR INDIVIDUALIZED EQUIPMENT SINCE 1881*

L. O. KOVEN & BRO., INC. 154-C OGDEN AVE., JERSEY CITY 7, N. J.
***PLANTS:* JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.**

Factors Determining the Choice of HOWARD FRACTIONAL H.P. *INDUCTION MOTORS*

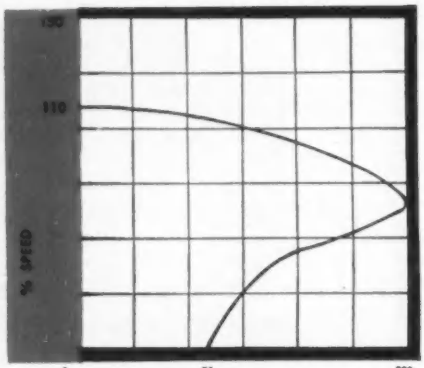


TORQUE TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by number of poles, with a No Load slip of approximately 5%.
2. Full Load speed decreases with an increasing load. Designed to operate at approximately 30% full load slip.
3. No breakdown torque.
4. Starting torque high approximately 125% full load.



INDUCTION CAPACITOR RUN TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by the number of poles, with a no load slip of 2 to 4%.
2. Constant Full Load speed, with a full load slip of approximately 10%.
3. Breakdown torque—approximately 200% full load.
4. Starting torque—approximately 75% full load.

HYSTERESIS SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by number of poles.
2. Starting torque equal to Full Load Torque.
3. Quiet operation.

RELUCTANCE SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by the number of poles.
2. Starting Torque Low, 50 to 75% of Full Load.

HOWARD

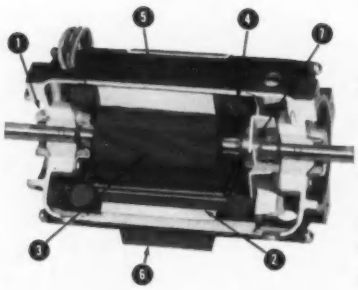
The increase in the use of Howard Induction Motors results from the overall superior performance characteristics of Induction motors over Series and Shaded Pole types.

basically Howard Induction motors have the following advantages:

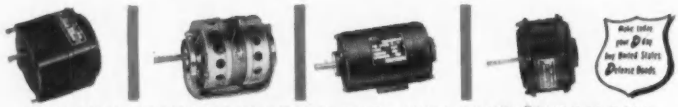
- Less maintenance—no brushes to wear, parts subjected to less wear. For applications where maintenance is difficult to handle.
- Constant speed under increasing load or varying power supply—for applications with exacting timing requirements where load or power supply are not constant.
- Extremely quiet operation both mechanically and electrically—for applications where noise level must be exceptionally low, professional tape recorders, etc.
- Low external field, in many cases requiring no magnetic shielding.
- Good efficiency up to 50% as against 40% maximum in Shaded Pole motors and 65% in Series motors.
- High power factor up to 85%.
- No radio or TV interference—for appliances and other home use applications.
- Good starting torque.
- Reversible in motion and reversible from rest.
- Wide range of H.P. ratings (1/8 to 1/1400) and gear ratios (2:1 to 3600:1).

Howard Induction Motors are currently used in a wide range of applications—business calculators, tape recorders, facsimile equipment, blowers for microwave relay stations, radar, projectors, teleprinters, gyro drives, automation instruments, etc.

Howard Induction Motors are available in Torque, Induction Capacitor Run, Hysteresis Synchronous and Reluctance Synchronous types. Costs are moderate but depend upon quantity. For full information on Howard Induction Motors, write for bulletin 56A.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors can be provided with ball thrust bearing for vertical operation or thrust loading.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formex insulated wire, impregnated and baked with top grade electrical varnish.
5. Case of sturdy, rigid casting always.
6. Mounting pads with holes drilled and tapped cast on frame. Special face mounting end bell available.
7. Internal fan for cooling.



OTHER HOWARD MOTORS: UNIVERSAL & D.C.—1/200 to 1/2 H.P. • SHADED POLE—1/2000 to 1/10 H.P. • SERVO MOTORS • GEAR MOTORS • BLOWERS

DEPT. PE-6 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4
942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

Drafting Department Heads! Now Is the Time to Gear Your Department to Meet Growing Production Demands!

NOW Is the Time to Get Your New, Modern Bruning Copyflex Machine!

Copyflex Model 500—Top mechanical speed of 40 f.p.m., front or rear delivery, automatic separation and stacking, many other features.

The boom in production means more pressure than ever for engineering drawings and prints. Right now is the time to replace that old inadequate reproduction machine you've been putting up with—now's the time to get a modern, efficient Bruning Copyflex.

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the left. These machines offer you the famous problem-free operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are the efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!

BRUNING Copyflex

Best Process! Best Machines! Best Selection of Materials!

Specialists in Copying Since 1897

CHARLES BRUNING COMPANY, INC., 4700 MONTROSE AVE., CHICAGO 41, ILL.

In Canada: Charles Bruning Co. (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 63-O
4700 Montrose Ave., Chicago 41, Illinois
Please send me information on Copyflex process and Model 500 machine.

Name_____ **Title**_____

Company_____

Address_____

City_____ **County**_____ **State**_____

in a new car . . .

in a used car . . .

stainless steel sells and re-sells

The Stainless Steel trim, molding and vital parts that add style and beauty to a car, inside and out, are features that help make the sale.

Stainless Steel has wide customer acceptance. It's easy to clean and keep clean. It's a tough, solid metal that will not corrode or dent and stands up to gravel, ice, salt and water.

The finish never fades and parts are easy to replace. Stainless Steel lasts the life of the car. It *sells* in a new car and it *re-sells* in a used car.

McLouth STAINLESS STEEL for automobiles

McLouth Steel Corporation
Detroit, Michigan

Manufacturers of Stainless and Carbon Steels

NEW BOOKS

Conference on Effects of Radiation on Dielectric Materials

PB 111863, 8 x 10½ *in.*, *paper-bound*, 169 *pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $4.25.

A conference on the effects of radiation on dielectric materials was held at the U. S. Naval Research Laboratory, Washington, D. C., December 14-15, 1954, under the joint auspices of the Naval Research Laboratory and the Office of Scientific Research of the Air Research and Development Command. This publication deals with the material presented at the conference.

The elementary effects of various radiations are reviewed and it is shown that they may be divided roughly into Wigner effects (discomposition) and charged particle effects. The terms M/N and G are defined and their applicability described. The phenomena in an ionization track include ionization and excitation, for the most part localized in spurs separated from each other by an amount determined by the velocity of the incident particle. The initial descussion relates both to ionic and extended molecule dielectrics. The following details pertain principally to the latter (polymers).

Symposium on Automatic Programming for Digital Computers

PB 111607, 8 x 10½ *in.*, 152 *pp.* paper-bound. *Available from U. S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $4.

In order to bring about an exchange of ideas and experiences concerning problems involved in the automatic programming of digital computers, and thus accelerate automatization of programming, the Navy Mathematical Computing Advisory Panel organized

(Continued on page 380)

EAGLE

CYCL-FLEX reset timer

Insures dependable operation and simplified control circuits

Designed with a sealed dial that covers the elapsed time indicator, the Cycl-Flex Timer permits direct mounting to machine panels that are exposed to oil and dust. Timer switches control four load circuits. Interlocking contacts provided without the use of auxiliary relays. Synchronous motor drive insures accurate timing.

The Cycl-Flex is one of the Eagle family of timers designed to fit into every industrial time control need. Eagle sales engineers, located in 30 principal cities, will analyze your timing applications without obligation.

FREE AUTOMATION BOOKLET

MAIL COUPON TODAY!

EAGLE
SIGNAL CORPORATION
Industrial Division
MOLINE, ILLINOIS
Eagle timers save time . . . save money

Eagle Signal Corporation
Industrial Division, Dept. PE-656
Moline, Illinois

Please send Bulletin 120 containing complete data on the Cycl-Flex Reset Timer and free automation booklet, "See What Timing Can Do for You."

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

(Advertisement)

Special Reports On Finishing Non-Ferrous Metals

NUMBER II—Paint Base, Corrosion-Resistant Finishing with Iridite

WHAT IS IRIDITE®

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a good paint base and decorative finishes for non-ferrous metals. However, continued developments have been so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can obtain proper surface preparation for painting and increase product durability with a single multi-purpose chemical pretreatment. Report I on decorative, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, it is an accepted fact that metal surfaces should be prepared before painting to make possible an efficient paint system. Naturally, this preparation should provide for good initial paint adhesion. Chemical treatments have proved extremely effective in this respect, particularly those of a neutral or preferably acid nature. Further, to be most efficient, chemical treatments should provide a non-porous barrier to maintain adhesion by sealing the metal from the paint and moisture. They should also provide a self-healing film which prevents lateral corrosion in the event that bare metal is exposed through scratching.

The Iridite chromate conversion coatings meet all these requirements. Iridite is a chemical conversion treatment for surface preparation. It provides initial paint bonding by molecular adhesion. It is acid in nature and produces a film that is gel-like and non-porous in structure. Thus, the Iridite film effectively seals the metal from the paint and from moisture penetration. Because the film contains certain relatively soluble constituents, it will protect areas scratched through to bare metal and prevent lateral corrosion. This is accomplished by a gradual leaching of these constituents into the damaged area.

Further, because of its gel-like, non-crystalline nature, the Iridite film will not affect the appearance or texture of the paint film, nor will it dust or powder to mar the painted surface. Because the film is non-porous, paint coverage is increased, thus substantial savings in paint costs will be realized. In addition, treated parts may be stored for long periods of time prior to painting without the risk of entrapped moisture causing blistering when painting.

Iridite chromate conversion coatings are widely used with equal ease and success under both baked and air-dried paint systems. While the actual adherence properties of the Iridite film do not increase appreciably with its thickness, corrosion protection does. The protection of the Iridite film is proportionate to its thickness and should be taken into consideration when selecting the Iridite to meet your needs. However, it is sometimes necessary to sacrifice maximum corrosion protection for appearance when a finished part is to be only partially painted. For example, it may be desirable to use a thin, clear, bright Iridite film if the unpainted areas must present a chrome-like appearance. A typical case is that of instrument housings on which the exterior is painted and the inside left unpainted.

On the other hand, if all surfaces of the product are to be painted and maximum corrosion protection is required, the heavier and most protective Iridite films should be used. For example, all surfaces of zinc die cast fruit juicers are finished with a highly protective Iridite film prior to painting to provide maximum resistance to the corrosive action of fruit juices.

Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. In addition to providing an excellent base for paint, the Iridite films also have high decorative value when used as final finishes in themselves.

These films can produce a wide variety of pleasing appearances including clear bright, iridescent yellow, bronze, olive drab and brown. In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to their functions as protective and decorative finishes, and as bases for organic finishes and bonding compounds, Iridites have low electrical resistance. Some can be soldered and welded. The film does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.

RESERVE YOUR

FREE

COPY NOW!

GET THIS

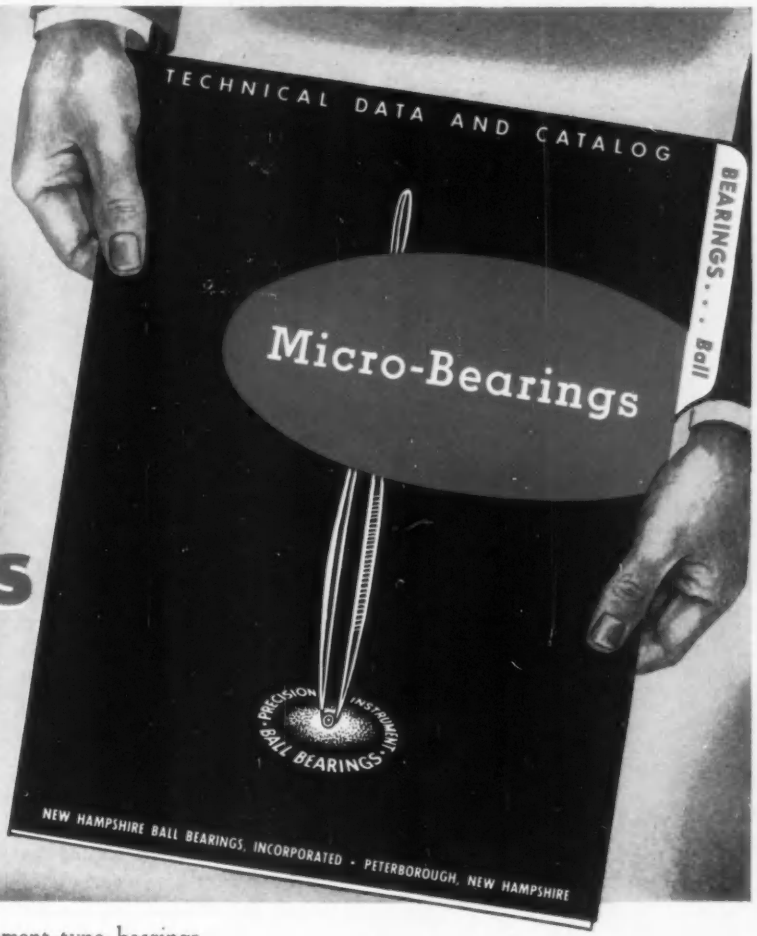
NEW

Technical Reference Manual and Catalog on

MICRO BEARINGS

SMALL INSTRUMENT BALL BEARINGS

This brand new concept in bearing catalogs will help solve your design problems!


TECHNICAL DATA AND CATALOG
BEARINGS . . . Ball
Micro-Bearings
PRECISION INSTRUMENT BALL BEARINGS
NEW HAMPSHIRE BALL BEARINGS, INCORPORATED • PETERBOROUGH, NEW HAMPSHIRE

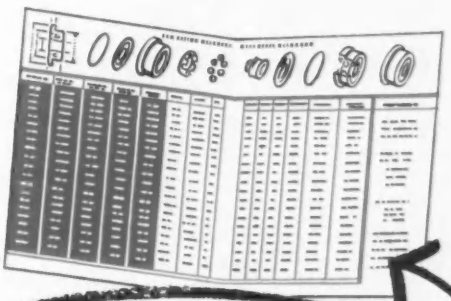
If you work with small instrument type bearings you'll find this new, authoritative publication an extremely valuable and handy source of engineering data arranged in convenient form for practical reference.

LOOK AT THESE FEATURES . . .

- A helpful survey article: "FACTORS TO CONSIDER IN SELECTING SMALL INSTRUMENT BALL BEARINGS."
- A complete, practical presentation of bearing facts:

Types of bearings	*Lubrication*
Materials	*Applications*
Components	*Radial and Axial play*
Engineering standards	*Torque*
Tolerances	*Mounting practice*
Dynamic and static loads	*etc.*

- Large, clear illustrations.
- Big, easy to follow charts.
- Convenient nomographs and conversion charts.
- Simple bearing designations make ordering easy.



WRITE TODAY . . . GET YOUR NAME ON OUR PRIME DISTRIBUTION LIST FOR MAILING SOON - "HOT OFF THE PRESS"!

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH, NEW HAMPSHIRE

We at Newark have many years' experience in the production of quality wire cloth. But we haven't stopped there. One division of our company is fully equipped and staffed to fabricate *any* part you need with a wire cloth insert.

We have experienced engineers ready to assist yours in the design of the part to assure making the best and most economical use of the mesh insert. And, we have the facilities and skilled personnel to fabricate the parts to your strict specifications in small lots or in production quantities to meet your production schedules.

It will pay you to investigate how you can take advantage of our experience in wire cloth manufacture and parts assembly. We shall be glad to quote on your requirements. Let us have complete details on specifications.

NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Send for Catalog E.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

a symposium. The speakers were invited from government agencies, universities and industrial organizations which have made significant contributions to the field of automatic programming. Their subjects included differentiators, compilers, generators, interpretative routines and universal automatic codes. The papers presented at the symposium have been collected into this report to constitute a source of useful reference material.

ASTM Standards on Petroleum Products and Lubricants

Prepared by ASTM Committee D-2. 6 x 9 in., paper cover, 954 pp. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $6.50, for members, $4.85.

This publication brings together in convenient form the various ASTM standard and tentative methods of test and specifications pertaining to petroleum products and lubricants. Included also, as information only, are 12 proposed methods of test, which are published in draft form for the purpose of soliciting comments. Such proposed methods have not been formally approved and are distinguished from the standards and tentatives by the absence of an ASTM serial designation.

Techniques for Application Of Electron Tubes in Military Equipment

PB 111644 R, Rex S. Whitlock, Electronic Components Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, paper-bound, 8 x 10½ in., 270 pp. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $5.

This technical report presents tube information primarily from the point of view of the equipment designer as a guide in the application of electron tubes. In Part I, tube properties are discussed. These are grouped according to ratings, characteristics essential in circuit operation, and properties detrimental to circuit operation. Part

(Continued on page 384)

for HAZARDOUS LOCATIONS

SKINNER EXPLOSION-PROOF Solenoid Valve
Only 3 27/32" high

Skinner X5 Series Explosion-Proof stainless steel Valves are ideal for use in hazardous applications. They are Underwriter Approved for Class I (Gasoline vapors, etc.), and Class II, Groups F (Grain dust) and G (Coal and coke dust), and offer you incomparable simplicity and flexibility of design.

These low-cost valves are expertly engineered to give trouble-free performance through millions of cycles. They're direct-acting, leakproof and spring loaded for operation in any position. Available in a wide range of types, voltages, pressures, flow control adjustments, port sizes and port locations.

SPECIFICATIONS: Type: Two- and Three-Way Normally Open, Normally Closed, and Directional Control; Pressure Range: 0-1000 p.s.i. Orifice Diameters: 3/64" to 1/4". Pipe size: 1/8" or 1/4" NPT; Voltage All AC and DC; Duty Cycles: Continuous or Intermittent. *Write today for Bulletin 526A*

SKINNER

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION • SKINNER CHUCK COMPANY

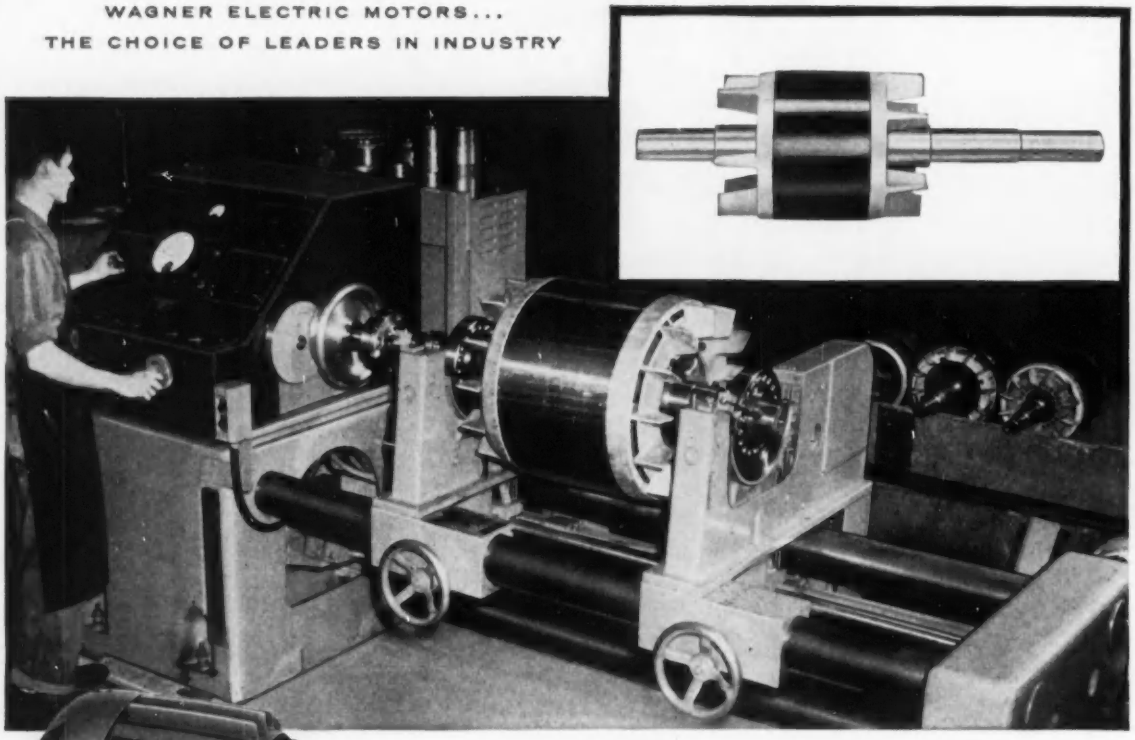
SKINNER ELECTRIC VALVES®

SOLENOID VALVES

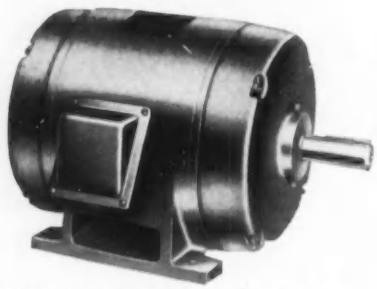
114 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

WAGNER ELECTRIC MOTORS...
THE CHOICE OF LEADERS IN INDUSTRY



Wagner totally-enclosed fan-cooled motor.
1 through 30 hp, NEMA Frames 182-326U.



Wagner open type drip-proof motor.
1 through 30 hp, NEMA Frames 182-326U.

DESIGNER'S NOTE:

All Wagner Motors are *DYNAMICALLY BALANCED* for smooth performance

Motor balance is important to fine machine tool performance. A well-balanced motor greatly reduces vibration—allows your machine tools to turn out the accurate work for which they are designed.

Every rotor, even in the smallest fractional hp rating, used in a Wagner Motor is dynamically balanced on balancing machines like that shown above.

Your selection of Wagner Motors for your machine tool applications gives you other benefits, too. You can specify totally-enclosed motors that are fully protected against damage from filings, chips, dirt, fumes, moisture; or open type drip-proof motors—in ratings through 500 hp. You add an extra selling point—Wagner Motors are *known* for dependable performance. You assure users freedom from costly motor maintenance and even more costly down-time. And—you give your customers motors that can get on-the-spot service when needed—anywhere in the United States.

M56-9

Wagner Electric Corporation
EST. 1891

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

NEW

AMERICAN offers SYNTHETIC FELTS

Thermal Resistance...Chemical Resistance!

NOW AVAILABLE!

- DACRON
- ORLON
- NYLON
- ARNEL
- ACRILAN
- DYNEL

Send today for fact sheets!

Now, American, through its technical research, has perfected the mechanical interlocking of the man-made fibers listed at the left, to produce three-dimensional felt structures.

These new Felts have exceptional *chemical resistance* with *thermal stability* to 300 F. They are non-hygroscopic, biologically stable and are available in a complete range of thicknesses. Precision engineering assures close density and thickness control.

The properties which characterize these new Felts are being utilized in filtration—laminated plastics as reinforcing material—high temperature bearing seals—gasketing. In fact, end uses are unlimited!

American's engineering and research staff is prepared to supply you with complete data and product recommendations.

WRITE TODAY!

American Felt Company

TRADE MARK

GENERAL OFFICES: 78 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

Low oil seal for every purpose!

Universal Oil-Seals are assembled units ready for installation at vital friction points. They are available in special designs up to 48" diameter shafts with optional leather, synthetic rubber or composition packings.

STANDARD SEALS CARRIED IN STOCK. WRITE FOR COMPLETE CATALOG.

—UNIVERSAL OIL SEAL CO.—
PONTIAC 12, MICHIGAN

II discusses the tube properties in relation to circuit design. It includes a check list for use of the circuit designer to insure coverage of all important design factors. Part III contains numerical data and special design considerations for specific tube types. Part IV presents product distribution curves derived from life test records where available. The concepts of specification control, operation within ratings, and tolerance of charactistics are emphasized throughout.

On the Mechanics of Magnetic Amplifier Operation

PB104106, R. A. Ramey, Naval Research Laboratory, Washington, D. C., paper-bound. 8 x 10½ in., 26 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $0.75.

A new theory of magnetic amplifier operation, developed at the Naval Research Laboratory, is presented. An elementary quasi-mathematical approach is used to demonstrate the application of this theory to known circuits. The method of analysis is also used to demonstrate a few of the new circuits which have been predicted by utilization of this new theory. These circuits have characteristics which are, in many ways, far superior to those of the magnetic amplifier circuits in use today.

This is an interim report; work on this problem is continuing. More exacting mathematical analyses based upon the concepts presented herein are being prepared by this laboratory and will be published as they are concluded.

Automatic Control

Prepared by editors of "Scientific American." 5½ x 8 in., paper-bound, 148 pp. Published by Simon & Schuster, Inc., 630 Fifth Ave., New York, N. Y. $1.

"There is going to be more and more automatic control in our lives. It is the means by which we will carry on big business and big government, production, finance, communications, trade and distribution in the complex and centrally organized civilization of our times. As citizens, we

(Continued on page 387)

STOP!

PERFECTION
WORM GEAR
SPEED REDUCERS
available in
5
COMPLETE SERIES

Don't go hunting around for Speed Reducers. Your nearest distributor has a complete series of Perfection Speed Reducers with ratios ranging from 5 to 1 to 60 to 1. Furnished with worm on top or bottom as desired.

Shafts are mounted in Timken anti-friction roller bearings. Threads are precision ground and accurately mated with worm gear. Heavy rigid cast iron housings . . . integral worm and shaft. The close limits to which all parts are held, assure maximum load carrying capacity, and long trouble free service.

Write for free 8 page Bulletin No. R-20 listing the complete Perfection Series.

AMERICAN STOCK GEAR DIVISION
Perfection Gear Company • Harvey, Ill., U.S.A.

New Taylor Copper-Clad Laminates

now available in production quantities

Why Taylor Copper-Clad Laminates Help Capitalize the Full Potential of Printed Circuits . . .

Taylor's ability to use high purity rolled copper—in weights of one, two or three ounces per square foot—assures production of materials that will more satisfactorily meet industry's needs because...

Rolled copper surface is smoother (freer from pits, pinholes and imperfections) . . . more uniform thickness . . . no sacrifice in conductivity. Result: Consistently satisfactory etching at better production rates.

After months of research and experimentation, Taylor is now in production on two brand new copper-clad laminates that give you opportunity to realize—on a sound basis—the full potentials of printed circuit construction.

Produced by an exclusive Taylor process that permits the use of readily available, high purity rolled copper, these laminates are supplied in two grades—XXXP-242 Copper-Clad, with a premium quality phenol paper base material; and GEC Copper-Clad, with a superior epoxy glass base material.

Taylor makes both of these copper-clad laminates in sheets approximately 37 x 49 inches . . . in thicknesses from .015 to .25 inches . . . with copper on one or both sides.

Whatever your experience with copper-clad laminates . . . whatever your ideas on the subject . . . it will be to your advantage to find out just what the new Taylor materials can do for you. Contact the nearest Taylor sales engineer . . . for more information or for your sample order.

Taylor GEC Copper-Clad provides . . .

- Superior electrical and mechanical qualities for critical applications.
- High electrical stability over wide humidity range.
- High resistance to dip soldering temperatures up to 500 F.
- High insulation resistance and surface resistivity after etching.
- Ready punchability.
- Good, uniform copper-to-laminate bond strength.

Taylor XXXP-242 Copper-Clad provides . . .

- Cold punchability. For intricate punchings—warm to 150 F. max.
- High resistance to dip soldering temperatures up to 500 F.
- High insulation resistance and surface resistivity after etching.
- Translucence. Permits easy checking of circuit alignment on opposite side.
- Good, uniform copper-to-laminate bond strength.

TAYLOR FIBRE CO. Plants in Norristown, Pa. and La Verne, California

Branch Offices

Atlanta	Detroit*	Philadelphia
Boston*	Indianapolis	Rochester*
Chicago*	Los Angeles	San Francisco*
Cleveland*	Milwaukee*	St. Louis
Dayton*	New York*	Rockville, Conn.

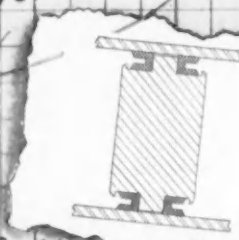
*Teletypewriter service at both plants and these branches.

Distributors

Grand Prairie, Texas
Houston
Miami
Toronto

TAYLOR
Laminated Plastics
Vulcanized Fibre

DESIGN NOTES—



PALMETTO
U-RINGS
replacing Cup Packings

New trend simplifies piston design... reduces machining costs... facilitates installation... reduces friction

Here's proof that it works—

A well-known manufacturer of welding machines ran a life test on a 9" air cylinder. Palmetto U-Rings 2620-172-A kept the cylinder operating at 96% efficiency, were in excellent condition after 9 million cycles... did a better job than 5 competitive makes! Now, after 2 years of use in production-made air cylinders, Palmetto U-Rings are still doing an excellent job.

Rectangular design of Palmetto U-Rings increases stability and strength and eliminates rolling in groove. Rugged, with wide lip flare for use in cylinders made from commercial tubing honed up to .030 over nominal sizes. Same sizes available in synthetic or fabric construction permits interchangeability of packing in low or high pressure cylinders. ALLOWS STANDARDIZATION OF COMPONENT PARTS... INCREASES EFFICIENCY.

It will pay you to redesign with Palmetto U-Rings. Write for information or ask our salesman to call—at no obligation

GREENE, TWEED & CO.
NORTH WALES, PA.

STAMPINGS
IN SMALL LOTS

This sketch briefly describes the cost of typical parts made for one of our earliest customers, whom we have served for the past thirty-four years.

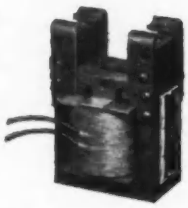
EXAMPLE
MATERIAL: C. R. STEEL
The cost of blanking, piercing, drilling and deburring, including all tools:
First 100 pieces.....$49.50
Each add'l. 100 pieces..... 8.50
Plus actual cost of material used for stampings.

We have the nation's very best facilities and know-how to produce short-run stampings at the lowest possible cost. Send your sketch, blueprint, or part, plus quantity, for prompt quotation.

DAYTON ROGERS
Manufacturing Company
MINNEAPOLIS 7M MINNESOTA

SOLENOIDS

G-211 solenoid, 10 lbs. at 85% voltage, 1½" stroke.



NA-726 solenoid; 16 lbs. at 1" stroke, 100% voltage.

G-200 line of solenoids. Replacement for all sizes of General Electric Co.'s CR-9503-200 line of solenoids.

NA-700 line of solenoids, replacement for National Acme solenoids, size for size, for all modifications.

The solenoids of both the above replacement lines are all thoroughbred Trombetta solenoids. All dimensions of interest to the user are the same as the respective solenoids they replace. The pull and pull characteristics are identical. In either case, we are in a position to furnish replacement units for any and all modifications. They are available for all voltages and frequencies, including direct current.

See our catalogs in Sweet's Catalog Service. Ask for more information.

TROMBETTA SOLENOID CORP.
329 N. MILWAUKEE STREET • MILWAUKEE 2, WISCONSIN

may hope to manage this revolution democratically and so to our advantage. We had better develop a clear understanding of what the term stands for and of the changes it implies in the way we make our living and conduct our affairs."

This is from this book's introduction and it indicates the kind of interest on the reader's part to which this book is addressed. Its contents are the product of a collaboration between its scientist-authors and the editors of the magazine "Scientific American," in which the chapters were first published during the past several years. Together, they provide a picture of the unifying, essential principles of automatic control, of the degree to which the movement has already transformed our business and industrial system and an insight into the major lines of future development.

Properties of Aluminum and Its Alloys

5½ x 8½ in., paper-bound, 204 pp. Published by Aluminum Development Assn., 33 Grosvenor St., London, W. 1, England, approximately $1.

Contains specifications, properties and compositions of British aluminum alloys and their proprietory names. This edition is related to the 1955 British Standards for Aluminum and Aluminum Alloys for General Engineering Purposes and also includes data for alloys as specified for aircraft use.

The book opens with a complete index of British Standards and Aircraft Specifications, followed by a brief classification of the main groups of aluminum materials. Tabulated data begin with the physical properties of aluminum and its alloys and in this section are included weight calculations and factors.

Following the main tables are notes on mechanical test requirements and test methods which define tensile properties such as proof stress and elongation, and include typical hardness values. Characteristics of aluminum are described under headings such as: super purity alloys; foil; electrical conductors; sintered aluminum.

Notes on characteristics affecting design include brief data on elasticity, strength in compression, shear stress, bearing and fatigue strengths. Data

(Continued on page 388)

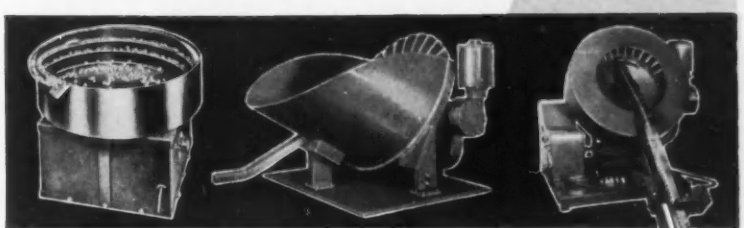
Is your production barometer up?

You Get a "RISING" PERCENTAGE WITH DPS POWER DRIVEN SCREWDRIVERS and SELECTIVE PARTS FEEDERS

Widely Adaptable to Individual Requirements

● Are you using DPS Power Equipment? If not, we urge that you get full details now . . . If you have a difficult problem, don't hesitate . . . Thirty years of experience with thousands of different applications . . . will enable us to cope with it and supply you with machines engineered to fit your needs. Progress demands DPS methods . . . Necessities in modern production where speed, economy and handling at minimum cost are so important . . . We can help you . . . Write today . . . Ask for catalog.

5 SCREWDRIVING MACHINES, Bench and Pedestal types. Model A pictured.



BOWL FEEDER, Vibratory type, to select and feed smaller, fragile parts.

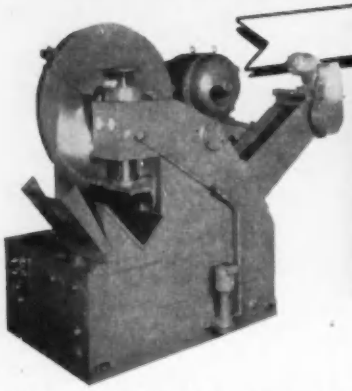
BARREL FEEDER with stationary ring cover, for heavy-duty, large production runs.

BARREL FEEDER conventional type, for parts requiring critical selection.

DETROIT POWER SCREWDRIVER CO.

2821-A W. FORT ST. DETROIT 16, MICHIGAN.

Proved Better
BY PERFORMANCE



Ruthman Gusher Coolant Pumps

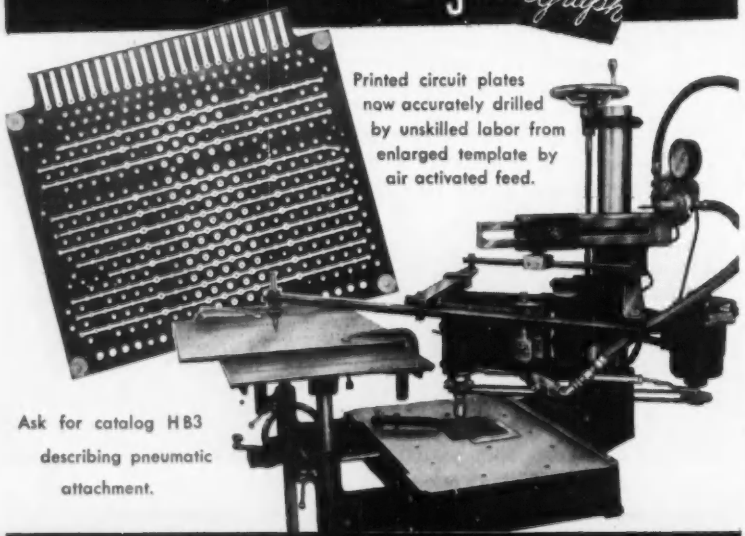
Illustrated is a Loma Saw SPH-36 equipped with a Gusher Coolant Pump and arranged for Billets and Slabs.Courtesy of the Loma Mach. Mfg. Co., Inc.

The year in and year out popularity of Ruthman Gusher Coolant Pumps with the leading machine tool builders is ample proof of their outstanding performance.

Gusher Coolant Pumps give you split second coolant flow — require no priming. Their sturdy construction, pre-lubricated ball bearings, electronically balanced rotating assembly assure you of long trouble-free life with minimum maintenance.

THE RUTHMAN MACHINERY CO.
1818 READING ROAD CINCINNATI, OHIO

TRACER-GUIDED DRILLING
100 HOLES P. M.
WITH NEW HERMES Engravograph



Printed circuit plates now accurately drilled by unskilled labor from enlarged template by air activated feed.

Ask for catalog HB3 describing pneumatic attachment.

hermes ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N.Y.

on the properties of aluminum at elevated temperatures and on "creep" are followed by a note on properties at low temperature. The appendix lists nominal compositions of selected alloys from Canada and Europe.

Scheme for the Identification of Piping Systems

ASA A13.1-1956, Sponsored by National Safety Council and American Society of Mechanical Engineers. 11 x 8½ *in.*, 8 *pp. Published by American Society of Mechanical Engineers,* 29 W. 39 *St., New York* 18, N. Y. $1.

This is a revision of the American Standard Scheme for the Identification of Piping Systems, originally affirmed in 1928 and reaffirmed in 1945.

It was in order to promote greater safety, lessen the chances of error, confusion or inaction, especially in times of emergency that a uniform code for identification of piping was first established, to warn personnel of outstanding hazards inherent in the materials involved. Therefore, while this standard has been prepared to specify the identification of the contents of piping systems primarily on the basis of stencilled legends, it also provides for the use of color as a secondary means of identifying the type of material contained in the system. It is urged that industry as a whole, and individual organizations, do not use color as a means of specifying the type of material contained in a piping system unless its use is in conformity with the provisions of this standard and unless it is supplementary to the use of legends.

Dynamics of Machinery

JAMES B. HARTMAN, *Professor, Lehigh University,* 6½ x 9¼ *in.*, 283 *pp. Published by McGraw-Hill Book Co.,* 330 W. 42*nd St., New York* 36, N. Y. $7.50.

This text is for advanced undergraduate and graduate students in mechanical engineering. Hence it presupposes that the reader had undergraduate courses in statics, dynamics, mechanics and calculus. These prerequisites

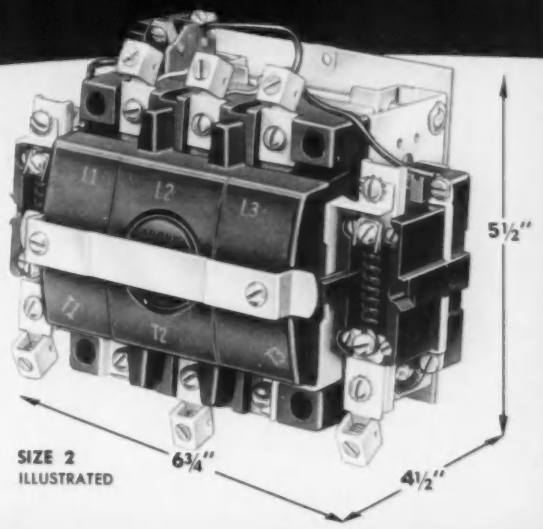
(Continued on page 391)

BY FAR THE *Finest* EVER BUILT

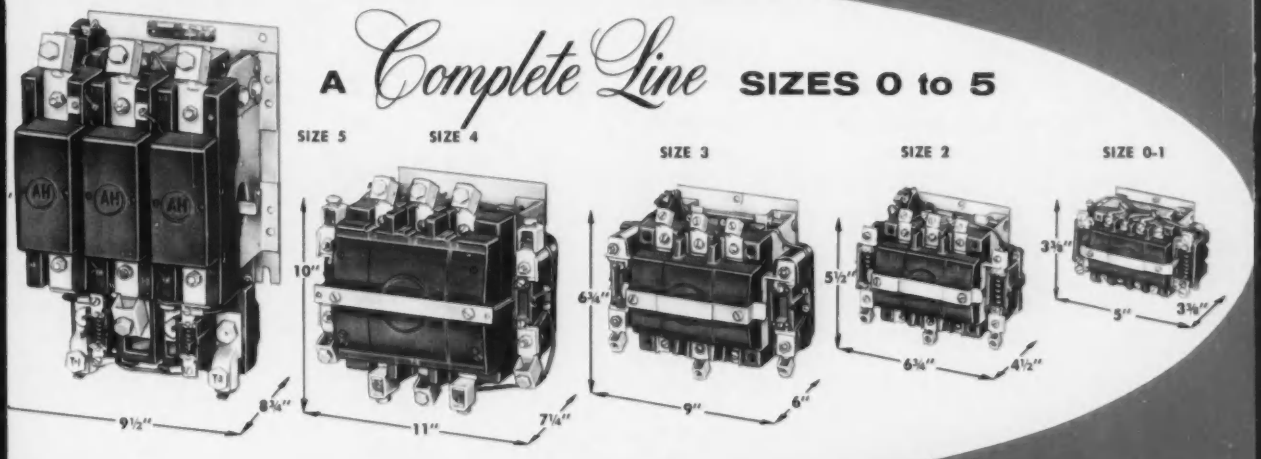
and HALF THE SIZE of Conventional Types

ARROW AH HART

MAGNETIC MOTOR CONTROLS



A *Complete Line* SIZES 0 to 5



When SMALL Space is a BIG Design Problem! . . .

Complex, modern machines call for multiple motor controls; fitting this control equipment into a reasonable area and providing ready accessibility is often a serious design problem. You can solve it easily by specifying Arrow-Hart Type "RA" Motor Controls. Radically smaller and lighter than conventional types, these starters and contactors offer the additional benefits of matchless performance, far greater dependability and much longer life.

With these ALL NEW Features in Sizes 0 and 1 . . .

- **NEW CONTACT DESIGN** . . . and a special alloy for longer life, greater resistance to welding. New metal contact carrier post.
- **RESINOX HOOD AND BASE** . . . for maximum tensile strength and added dielectric strength.
- **NEW AUXILIARY SWITCH** . . . improved, sturdy mechanism; front mounting for easier installation and removal.
- **NEW, SIMPLIFIED "RA" MECHANISM** . . . same compactness plus more efficient operation in industrial atmospheres.

LEADING DESIGN ENGINEERS DEPEND ON ARROW-HART CONTROLS TO SAVE SPACE, INSURE PEAK PERFORMANCE . . . TURN THE PAGE FOR OUTSTANDING EXAMPLES.

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC CO., Hartford 6, Connecticut

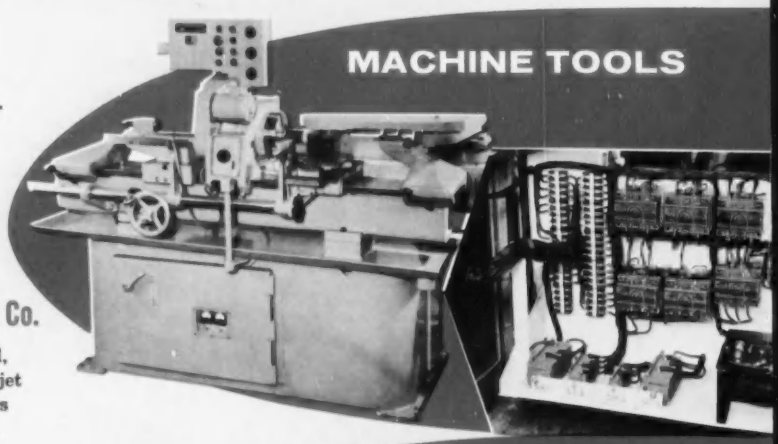
The Leaders look to ARROW AH HART *Advance Design*

MOTOR CONTROLS

. . . FOR SPACE-SAVING COMPACTNESS

. . . FOR PERFORMANCE-BUILDING DEPENDABILITY

MACHINE TOOLS



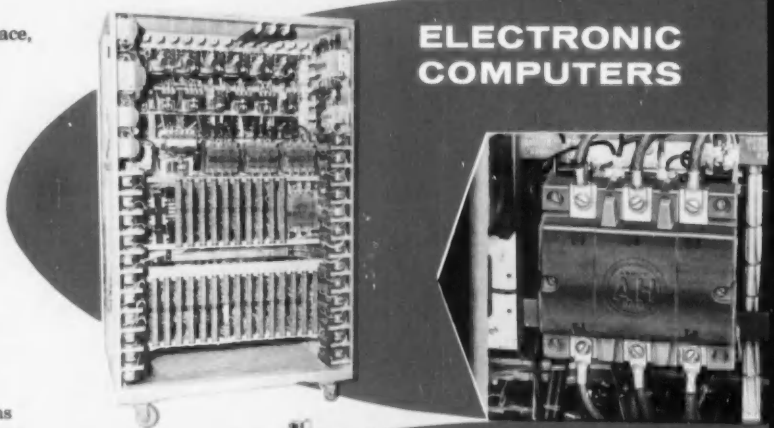
MODEL 102 AIRFOIL MILLING MACHINE

MANUFACTURED BY

The New England Machine & Tool Co.

This ingenious machine mills the original, 3-dimensional masters from which turbo jet blades are manufactured . . . does in hours a job once requiring weeks of hand work. Complexity of the operating and control mechanisms placed a high premium on space, but the 5 smaller, lighter A-H Magnetic Controls were easily mounted on an unusually compact door-back panel that swings out for instant accessibility.

ELECTRONIC COMPUTERS



TYPE 704 ELECTRONIC DATA PROCESSING MACHINE

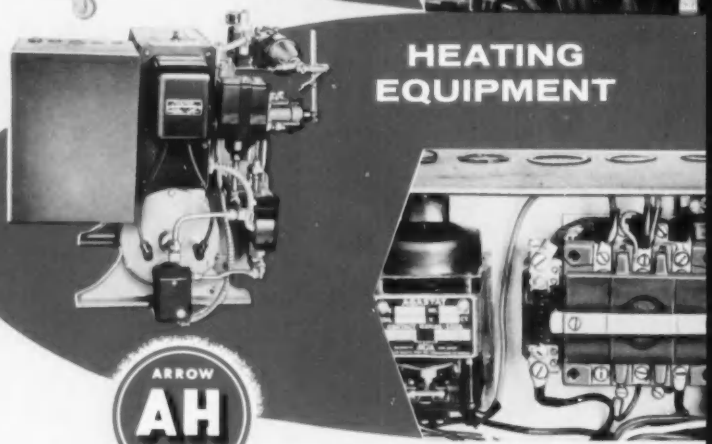
MANUFACTURED BY

International Business Machines

CORPORATION

These electronic machines are designed primarily for the use of engineers and research scientists. They are capable of performing more than 4000 multiplications or divisions per second. The 10 Arrow-Hart Contactors included in the very complicated power distribution unit were a natural choice to save valuable space. Other A-H Controls are also utilized in other parts of the machine.

HEATING EQUIPMENT



HEV-E-OIL BURNER

MANUFACTURED BY

Cleaver-Brooks Company

Simple, compact and efficient, this modern unit uses low cost, high heat heavy oils to provide economical heat for commercial and industrial buildings. Arrow-Hart Control – an "RA" Starter and a Miniature Relay – occupies little space in the small panel, leaves ample space for easy wiring.

ARROW AH HART

ARROW-HART

MOTOR CONTROL DIVISION

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY

103 HAWTHORN STREET, HARTFORD 6, CONNECTICUT

Offices, Sales Engineers and Warehouses in Principal Cities

Quality MOTOR CONTROLS • WIRING DEVICES
ENCLOSED SWITCHES • APPLIANCE SWITCHES

MAIL COUPON TODAY FOR COMPLETE INFORMATION

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Connecticut
MOTOR CONTROL DIVISION

Please send my copy of the A-H Motor Control Application folder. PE

name _____

position _____

company _____

co. address _____

city _____ zone _____ state _____

permit the author to: (1) reexamine dynamics from a more mature viewpoint; (2) extend a two-dimensional consideration of kinematics and dynamics to the three-dimensional case, by means of vector notation; (3) provide a transition from basic work in mechanics to more advanced graduate work in dynamics; and (4) introduce the reader to certain mathematical techniques now becoming widely used in the field of dynamics, automatic controls and servomechanism.

Mathematical techniques not encountered in the usual undergraduate course in dynamics, such as the use of La Place transforms, are developed as needed. Rigorous proofs are omitted, but sufficient theory is presented to give the user confidence. At the end of each chapter is a set of problems with answers.

Instrument Engineering—Volume III

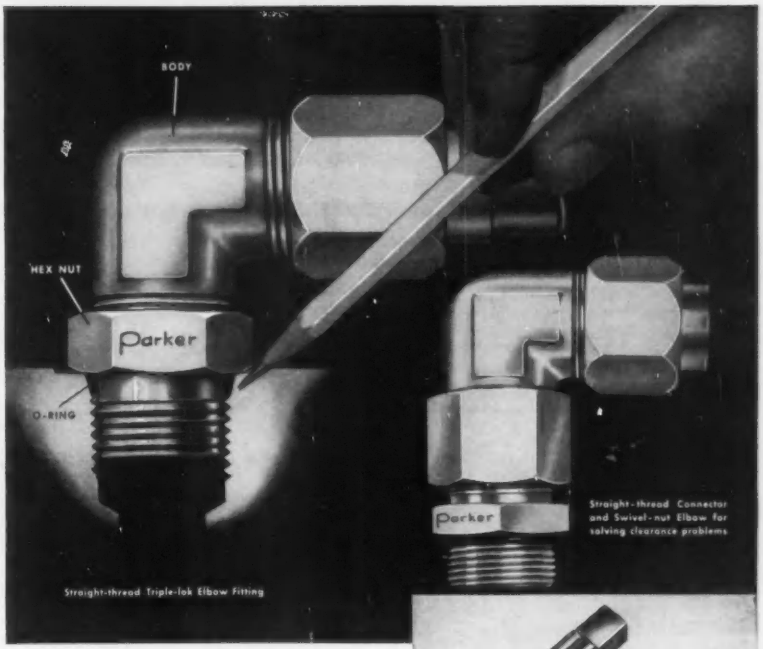
CHARLES S. DRAPER, *Head, Dept. of Aeronautical Engr.*; WALTER MCKAY, *Assoc. Prof. of Aeronautical Engr.*; SIDNEY LEES, *Asst. Prof. of Aeronautical Engr.*; *Massachusetts Institute of Technology, Cambridge, Mass.* 8¾ x 11 *in.*, 879 *pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $17.50.

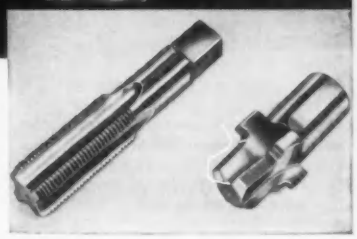
"Instrument Engineering" (three volumes) presents a generalized method of attack on problems of measurement and control. It is a comprehensive reference for the practicing engineer and students familiar with college physics and differential equations. Concepts, theory, methods and results are combined in a unified pattern effective in handling simple and complicated situations.

This pattern is developed in three phases illustrated by examples based on measuring instruments, control system components, regulators, servomechanisms, feedback controllers and computers.

Volume III contains examples in which the theory, methods, and techniques described in the first and second volumes are applied to typical cases. Methods for solving measurement problems are built up in Part I of Volume III by means of typical examples, beginning with thermometers that have the simplest possible

(Continued on page 393)





Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Cat. 4301.

TUBE AND HOSE FITTING DIVISION
Section 414-L
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New plastisol sprays extra-thick coating

How to make finishes stick tight to magnesium and aluminum

A primer is only as good as its adhesion. Years have passed since Unichrome Primer AP-10 was first developed as a primer for light metals. Users have had ample experience to confirm what primary producers of the metals have long known about this unique and remarkable primer. The consensus: AP-10 has superior adhesion; its use protects against peeling of the top or finishing coats.

TESTS THAT PROVE ADHESION

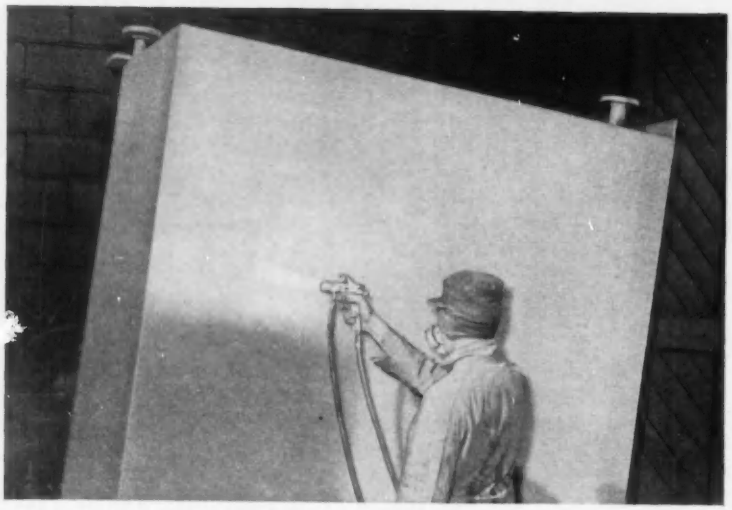
When an automotive producer primed magnesium panels with Primer AP-10 and immersed them in water, there was no effect on adhesion even after 500 hours. When an 8 lb. weight dropped 20 ft. on magnesium panels, rupturing them, Primer AP-10 still held tight even at torn edges. When magnesium was first primed with AP-10 and then finished with a top coat, the coating still adhered after 100 hours of salt spray, which was not the case with coatings over the ordinary primers tested.

Unichrome Primer AP-10 enables engineers to specify magnesium and aluminum for products with full confidence that these can be well protected against corrosion and durably finished with lacquers or enamels. It firmly anchors Unichrome lacquers and enamels, or those of other manufacturers. Ask for more details.

METAL & THERMIT
CORPORATION

General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
Metal & Thermit—United Chromium of Canada, Limited, Toronto

Unichrome "Super 5300" Coating builds 60 mil film per coat . . . gives heavy duty corrosion-protection



Tank getting a heavy protective coating with Unichrome Plastisol. Large structural parts of products can likewise be durably finished.

A new and unusual plastisol formulation has been developed by Metal & Thermit, a pioneer in this type of coating. Unichrome "Super 5300" Coating delivers the full solids content of vinyl plastisol right through a spray gun. It enables a coat 60 mils or more to be applied successfully in one application.

THICK AND TOUGH

Amounting to a vinyl "sheet" material, single or multiple coats of this new plastisol can be used to good advantage on many of the products where plastic or rubber sheets are generally specified. Super 5300 Coating also provides a durable, protective finish for large uneven surfaces where only a fluid material can be applied. Good performance is assured for two reasons. (1) With spraying, there are no seams or joints where corrosives might penetrate. (2) Vinyl plastisols have a unique combination of chemical and physical properties.

THE ADVANTAGES

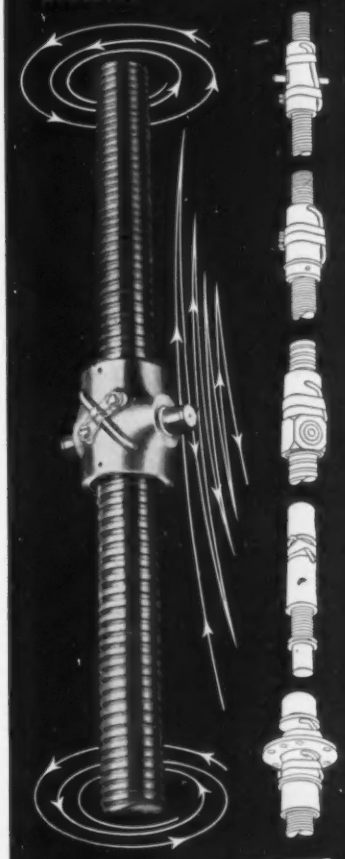
Curing quickly at 350° to 365°, Unichrome Plastisols form rugged, resilient coatings with an attractive satin finish. They insulate electrically, absorb impact, don't chip or crack, resist abrasion and erosion, deaden sound.

They give extraordinary protection against a wide range of acids, alkalies, alcohols, salt solutions and moisture. With plastisol protection, ordinary metal parts and products often prove suitable for unusually severe service conditions.

For companies without adequate baking facilities, Metal & Thermit can recommend nearby firms that specialize in applying "Super 5300" Coating. Send for Bulletins that tell more about plastisols.

beaver
ball screws

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.



Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

performance equations. The discussions include instruments and measuring systems of increasing complexity, including electromechanical measuring devices, pressure-measuring systems, integrators and differentiators, analog computers, and vibration-measuring equipment. Volume III is a useful self-contained text and reference book on measuring instruments and systems.

Thermal Power from Nuclear Reactors

A. Stanley Thompson, *Chief Engr., Nuclear Power Dept., Studebaker-Packard Corp., and* Oliver E. Rodgers, *Asst. General Manager, Government and Industrial Products Div., Studebaker-Packard Corp.* 6 x 9¼ *in., 229 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $7.25.

This is the first book on atomic reactors written from a mechanical engineer's viewpoint. The introductory chapters give a concise review of nuclear fission and a general description of nuclear reactors, helpful in orienting the engineer to current thought of physicists.

Stressing a design approach, the work discusses problems of reactor development which confront the engineer in atomic power plants. Engineering problem-solving techniques, such as numerical and dimensional analysis, are applied to these problems, and workable design criteria are evolved. Some of the problems of reactor development treated in this manner are thermal stresses, transient behavior of reactors, and distribution of gamma rays and neutrons.

Semiconducting and Luminescent Materials

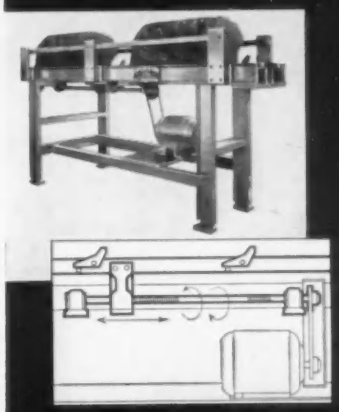
Semiconducting and Luminescent Materials and Their Applications, 1954 issue. Sponsored by the Electrochemical Society, Inc. and compiled by the Battelle Memorial Institute, 9 x 11½ *in., 200 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $5.

This compilation of literature abstracts has been prepared by the Solid State Devices Div. and the Physical

(Continued on page 395)

The same principle used in raising landing gear

automatically shuttles engine blocks



Beaver Ball Screws were selected by Spurgeon Co., Van Dyke, Michigan, for this device which synchronizes transfer of engine blocks between production machines—WHY?

1. Superior in performance and wear to Acme screws. Less power required.
2. Costs less to install and maintain than hydraulic cylinder. No oil leakage.
3. Costs less than air cylinder and costs less to maintain. Operates smoother. No air hookup required.

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

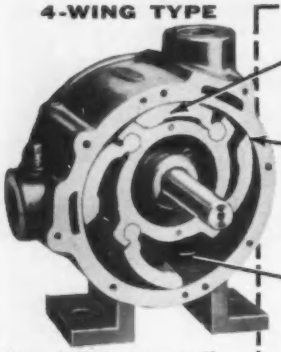
Exclusive Features of

LEIMAN Rotary Air and VACUUM PUMPS

bring you

★ High Vacuum
★ Smaller Size
★ Greater Volume
★ Lifetime Operation

4-WING TYPE



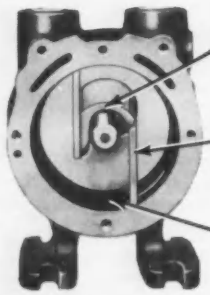
Curved Wings on easy-action hinge, maintain continuous wall contact.

Cast Iron Wings and Cylinders hone themselves to hard, glossy smoothness—take up their own wear—assure leak-proof seal for years.

Extra-large Air Space provides greater capacity, permits use of smaller pump.

Vacuums to 20" Hg.; pressures to 15 psig.; displacement to 162 c.f.m.

2-WING TYPE



Automatic Wing Adjuster assures wing-to-wall contact, prevents sticking, guarantees positive action.

Extra-long Steel Wings (not composition) provide long wear. Cylinder walls made of durable cast iron.

Large air space provides more compact pump.

Vacuums to 29.9" Hg.; pressures to 20 psig.; displacement to 40.6 c.f.m.

Install LEIMAN AIR PUMPS

for dependable Vacuum (Suction) and Pressure

FREE ENGINEERING DATA

- *Application Book* showing 60 "how-to-do-it" blueprints of actual applications.
- *16-page Catalog* showing construction, types, sizes, capacities, etc.

Precision-made, compact Leiman Air Pumps have fewer moving parts — no tips or blades to renew — need no maintenance except occasional oiling — run for 10, 15 and 20 years without trouble or shutdown. Over half a million installed. Consult our engineers on any air application.

SEE OUR CATALOG IN SWEETS FILE

LEIMAN BROS., Inc.

107 Christie St., Newark 5, New Jersey

Contacts by Makepeace

On receipt of your specifications we shall be glad to quote lowest quantity prices or have our engineering department contact you to assist in design if you prefer.

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.

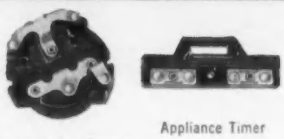
PRECISION ENGINEERED FOR ACCURACY

Spot Lay®

QUALITY CONTROLLED FOR SERVICE

Crossbar Raised Lay

QUANTITY PRODUCED FOR ECONOMY



Automobile Switch Appliance Timer

ENGELHARD INDUSTRIES

D.C. SOLENOIDS

with A N CONNECTOR

Synchro-Start MODEL SS-A Solenoid has been developed to meet the demands of many customers requiring a standard aircraft type fitting.

These ruggedly constructed solenoids are available for use on 6, 12, 24 and 32 volt systems. They have a 10 lb. pull over ½ inch stroke and power consumption is 220 Watts pulling and 6.5 Watts continuous.

Further information upon request.

SYNCHRO-START PRODUCTS
INCORPORATED
8151 N. RIDGEWAY AVE. • SKOKIE, ILL.

Chemistry Div. of Battelle Memorial Institute. The digest was originated to augment research activities. Because of the large number of publications dealing with semiconducting and luminescent materials, this compilation provides a ready reference to pertinent literature.

The principal sources of reference have been the various abstract journals; where possible, oral papers and other articles have been abstracted. An attempt has been made to present the most important experimental results or conclusions and to minimize the necessity for the reader to obtain the original article. By including this information and by supplying subject and author indices, the compilation serves as a fairly complete desk reference in this area of technology.

Because both foreign and domestic publication abstracts are included, the period covered by this publication is not exactly defined by a calendar year. Foreign periodicals are covered from about September of 1953 through September of 1954, while domestic publications are covered from about Dec. 1953 through Dec. 1954.

This is the 1954 issue of these abstracts. Two full years of organized abstracts on this subject can now be obtained. This volume uses essentially the same format as the 1953 issue. An improvement has been made in providing greater detail on each abstracted article. Fifty-three pages are devoted to germanium and silicon and their applications. Over 220 abstracted articles are included in these 53 pages. The entire volume contains over 750 abstracted articles.

Use of Radioactive Self-Luminous Markers as Sources of Illumination

PB111746, L. J. Boardman, Photometry Branch, Optics Div., Naval Research Laboratory, Washington, D. C., paper-bound, 8 x 10½ in., 21 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $0.75.

Various studies show that radioactive self-luminous markers can be used as simple, inexpensive and reliable sources of illumination to assist some operations under dark conditions. Strontium-90 is the most suit-

(Continued on page 396)

let us make a

Clipper *joint . . .*

for you

Are you looking for a better, faster way to fasten belts, aprons, tapes or ribbons? Would you like to slash maintenance time by putting an easy-to-fasten joint in endless belts? The fastest way to join these ends is with Clipper Hooks and Lacers.

Long used for lacing power transmission belting, Clipper fasteners are now proving their cost-cutting value in materials handling equipment, automatic pin setters, laundry equipment, food harvesting and processing equipment and in many other applications.

They produce a smooth, flexible joint in a hurry.

Let us demonstrate the advantages of a Clipper joint on the product of your choice. Send us a small sample (or the complete belt, apron, tape, or what have you) and we'll make you a Clipper joint FREE, without obligation.

Write, wire or call today for details and literature.

Ask your Industrial Distributor for Clipper Products

Clipper BELT LACER COMPANY

986 Front Ave., N. W., Grand Rapids 2, Michigan

Let's Talk About

Sealing Service

DURAMETALLIC is ready to help you with those stuffing box problems . . . we've been doing it for industry for 38 years. Experienced factory-trained sales and service engineers are located in all sections of the U.S.A.

Without charge, a staff of research and development engineers at our Kalamazoo plant are ready to help you with your sealing needs.

When seeking an answer to satisfactory sealing . . . put it up to Durametallic.

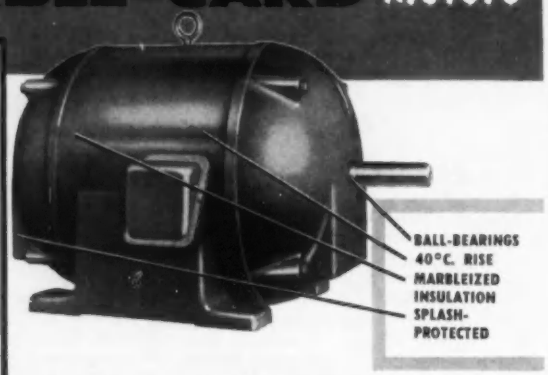
Write Today for Bulletin File No. DM-PG

DURAMETALLIC CORPORATION

KALAMAZOO, MICHIGAN

Get the facts on

MARBLE-CARD *motors*



1/6 to 125 HORSEPOWER

All Marble-Card STANDARD motors have these wanted features — all are available with both old and new NEMA frames *at same price.*

ASK FOR NEW CATALOG 55-1

CHARTER NEMA MEMBER

MARBLE-CARD ELECTRIC CORPORATION

GLADSTONE, MICHIGAN

AFFILIATED WITH MARBLE-ARMS CORPORATION

able of the present radioactive isotopes for exciting the phosphors in the markers.

Experiments were made using single markers and groups of markers in a variety of colors, luminances and distances. Green markers are the most efficient illuminators since the spectral energy distribution of the light from green markers has its maximum at about the same wavelength as the maximum of the sensitivity curve of the dark-adapted eye. The distributed luminance of a white wall, illuminated by various groups of markers, was measured to show the extent of useful luminance. Various tests revealed many uses that are possible. In working with tools, the area of useful illumination is at a maximum when the markers are held 2 or 3 ft from the work, and the tools can be quickly selected when a white wall background is as low as 0.02 μ L. With a 50-μ L marker held in the hand as a flashlight, it is possible to read a printed page held close to it, write notes, or walk among obstacles in the dark. A high-luminance marker of 300 μ L is equivalent to 6 of the lower intensity markers in illuminating areas having a radius from 2 to 4 ft.

This is an interim report on this problem; work is continuing.

Full-Wave, Reversible-Polarity, Half-Cycle-Response Magnetic Amplifiers

PB 111747, C. B. House, *Applications Branch, Solid State Div., Naval Research Laboratory, Washington, D. C., paper-bound, 8 x 10½ in., 29 pp. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $1.*

A full-wave magnetic-amplifier circuit which gives an output that is reversible in polarity or phase is discussd in detail. Two different methods of control and a general comparison of their merits is included. The amplifiers are of the half-cycle-response type with a comparatively high gain per stage. The basic amplifier is controlled by either alternating or unidirectional voltages and may be arranged to give either a-c or d-c outputs. Expressions for efficiency versus installed capacity for representative amplifiers are also derived. Some con-

(Continued on page 399)

The gears in an automatic nut former have to be tough and strong to withstand heavy, varying loads. Yet, the castings from which they're made should be easy to machine. That's why this gear for a Waterbury Farrel Automatic Nut Former is made from ASTM-50 gray iron with a nominal composition of 1% nickel and .50% molybdenum.

Moly gives cast iron gears higher strength with toughness and good machinability

"To insure a tough, easily machined gray iron for the gears in our Automatic Nut Formers," says Henry C. Griggs, Metallurgist for Waterbury Farrel Foundry & Machine Co., "we specify .50% molybdenum in our ASTM-50 material. The properties of this material contribute importantly to the reputation of Waterbury equipment for accuracy and high speed production under severe operating conditions."

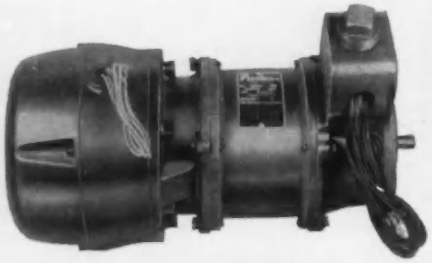
Molybdenum helps to give reliable and reproducible castings – very important factors in consistent performance of gears.

Investigate moly irons. They may be the key to better performance in many of your gear applications.

For the first two in a series of bulletins, "Why Moly Iron," or for technical assistance, write Climax Molybdenum Co., Department 61, New York 36, N. Y.

CLIMAX MOLYBDENUM

Where Special Requirements Dictate Motor Construction



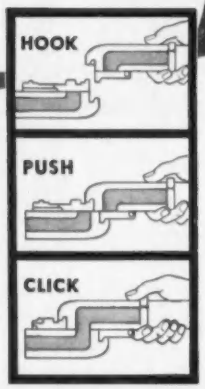
This peculiarly shaped motor opens and closes pipe line valves without fail in all types of weather. It is a special weather-proof torque motor designed by **Peerless Electric** in cooperation with a valve manufacturer and is equipped with an electrically operated brake. The motor shown here measures approximately 10" in diameter and 31" in length but **Peerless** can produce it in many other sizes.

The outstanding product performance attained with this motor is a result of teamwork engineering — **Peerless** — OEM cooperation. Submit your next motor problem to **Peerless.** We'll work with you to design or select the one motor that operates your product best.

By Invitation Member
Emblem of BUSINESS CHARACTER
Rice Leaders of the World Association
Represents High Standing in NAME · PRODUCT · POLICY

ELECTRIC MOTOR DIVISION

THE *Peerless-Electric*® COMPANY
FANS • BLOWERS • MOTORS • ELECTRONIC EQUIPMENT
1509 W. MARKET ST. • WARREN, OHIO



Char-Lynn Hydra-Seal Hose Coupler

Low pressure drop in coupler allows full power for work.

Absence of internal parts assures least pressure drop of any coupler and eliminates cleaning problems. Designed and engineered as a quick-connect, self-sealing, break-away coupler for all fluid carrying lines.

Write for free catalog and further information.

Char-Lynn

CHAR-LYNN CO.
2843 26th Ave. So., Dept. PE6, Minneapolis 6, Minn.
Member — National Fluid Power Association

VELLUMOID

What about "BEATER MIX" Gasket Materials?

- The "beater mix" process is not in itself a guarantee of superior performance.
- A gasket must first of all *seal*. For many applications it must be oil or fuel resistant. On all applications it must never deteriorate in service.
- VELLUMOID'S VELBUNA WG-1 and WG-4 beater mix Buna N and fibre gaskets *seal*. They are oil resistant, have high torque retention and work effectively on applications where firm, dense materials at reasonable cost are required.
- Send for sample gaskets for testing on your own applications. The Vellumoid man in your territory is always available for consultation.

VELLUMOID COMPANY
56 ROCKDALE ST. · WORCESTER, MASS.

siderations of the circuit as a suppressed-carrier modulator are presented with waveform shapes and fidelity characteristics.

This is an interim report; work on the problem is continuing.

Atomic Power

Prepared by Editors of Scientific American. 5½ x 8 in., paper-bound, 180 pp. Published by Simon & Schuster, Inc., 630 Fifth Ave., New York, N. Y. $1.

This is a book about atomic power. It deals with the constructive, beneficial or peacetime uses of energy liberated from the atomic nucleus. All but two of the chapters were written by authorities closely associated with the topics on which they write. The chapters were first published as articles in the monthly issues of the magazine "Scientific American." Brought together here, these articles published over a period of several years contribute new relevance to one another and to the large subject with which they are all concerned.

Magnetic Particle Clutch And Its Application to Servomechanisms

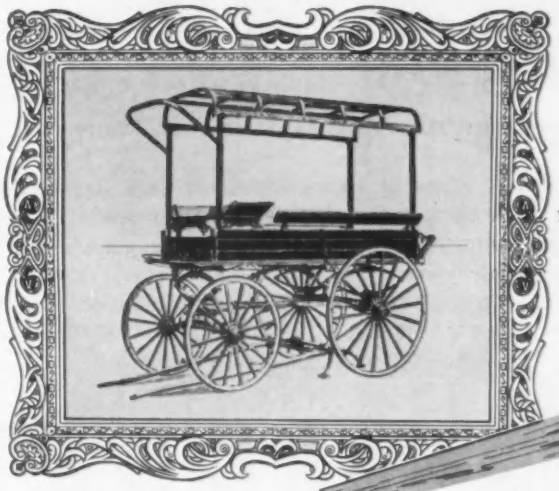
PB 111782, 8 x 10½ in., 22 pp. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. For price write J. E. Wheat, Chief, Newsletter Section, at above address.

A study of various clutch configurations reveals that for minimum inertia the magnetic particle clutch should employ a coil which is located externally with respect to the remainder of the clutch. This external coil allows the output member to be made of a low-inertia thin-walled cylinder. The coil configuration may be of the salient pole or of the toroidal coil structure. Calculated data indicate that, for clutches with high torque-to-inertia and high dissipation-power-to-torque ratios, the salient pole structure is preferable to the toroidal coil structure when weight and space are important.

In a unique application of clutches as the prime mover in a servomechanism, it was found that the magnetic

(Continued on page 401)

How about Malleable?



Wagon of about the year 1885, completely "ironed" with standard malleable iron castings.

New metals aren't the only answer! For 130 years malleable iron has kept pace with modern design requirements

Malleable proved its worth long ago in parts requiring toughness, ductility and resistance to shock. Through years of processing refinements, today's malleable iron is a superior metal, adaptable to meet job demands—ties in with modern-age requirements.

Versatile castability, high ratio of yield point to ultimate strength, and remarkable ease of machining mark malleable for new uses every day. And still further advancements in malleable and pearlitic malleable production assure higher capacity to serve new users whose forward planning and design awareness recognize the many advantages of this "old-new" material.

It's worth your while to take malleable iron castings into consideration when designing new products or when seeking new cost and assembly savings. Consult your nearest malleable foundry, or write to this Society for information.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building Cleveland 14, Ohio

ENGINEERS FOR IMMEDIATE PLACEMENT

- **Electrical engineers**
- **Mechanical engineers**
- **Electronic engineers**
- **Computer engineers**
- **Solid-state physicists**

ENGINEERING AT NCR MEANS:

IMMEDIATE, PERMANENT POSITIONS in Mechanical Engineering, Electrical Engineering and Physics Research Division.

ENGINEERING PROJECT WORK in Adding Machines, Cash Registers, Accounting Machines, Computers and related Data Processing Equipment in Dayton, Los Angeles and Ithaca, New York.

OPPORTUNITIES IN DESIGN, development, production-engineering and packaging of mechanical, electronic and electro-mechanical devices.

SOME EXPERIENCE IN DEVELOPMENT, design and application of high-speed, light-weight mechanisms of the intermittent-motion type—or experience in digital devices and components is desirable, but not essential.

AMPLE TRAINING and orientation is available to all employees.

ENGINEERS

AS AN NCR ENGINEER, YOU WITH YOUR FAMILY, WILL ENJOY:

UNLIMITED OPPORTUNITY in the broad, ever-expanding field of Business Machine Engineering and Research.

AN EXCELLENT SALARY, plus exceptional benefits of lifetime value for you and your family.

A RECREATIONAL PROGRAM for year-round enjoyment for the entire family, including a new NCR Country Club with 36 holes of golf, and a 166-acre employees' park for outings with swimming, boating and supervised play for children.

LIVING IN DAYTON—an attractive, progressive city with outstanding school facilities.

YOUR WORK AT NCR with its friendly, family atmosphere, where you work with people who, like yourself, have decided to build their professional future with NCR.

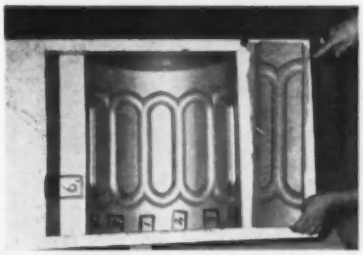
ACT AT ONCE

- **Send resume of**
- **your education, experience**
- **and geographic preference to:**
- **Employment Department,**
- **Professional Personnel Section 2**

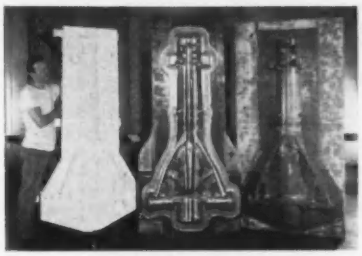
THE NATIONAL CASH REGISTER COMPANY • DAYTON 9 • OHIO

HYSOL
Plastic Tooling Materials . . .
• *Cut Costs*
• *Save Time*
in these applications

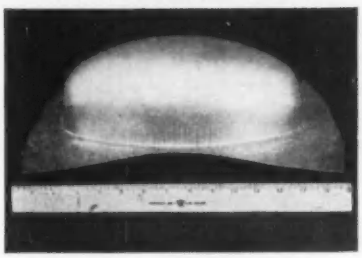
• CORE BOXES •



• KELLER PATTERNS •



• DIE FORMED PART •



HYSOL
PROGRESSIVE PRODUCTS
FROM CHEMICAL RESEARCH

• *Write for details* •

HOUGHTON LABORATORIES INC.
150 HOUGHTON AVE.
OLEAN, NEW YORK
In Canada
HYSOL (CANADA), LTD.
184 Laird Drive
Leaside, Toronto 17, Ontario

particle clutch shows an advantage over a servo motor of comparable rating in regard to control power and response time.

This is a final report on one phase of the problem relating to the magnetic fluid clutch; work on other phases of the problem is continuing.

Handbook on Titanium—Parts I and II

HEINRICH K. ADENSTEDT, *Avco Mfg. Corp.; Part I, PB 111631, 8¼ x 10¾ in., paper-bound, approximately 300 pp, $3.; Part II, PB 111873, 8¼ x 10¾ in., paper-bound, approximately 200 pp, $4.25. Both available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.*

The information in this handbook has been collected on specific properties and procedures of titanium by literature survey and by personal contact with the proper persons and institutions. It is in two volumes, Parts I and II.

The data that were collected have been evaluated and are condensed in this report. The three major sections of titanium technology covered in Part I are production, physical metallurgy and properties. Part II covers laboratory procedures and fabrication.

Infrared—A Bibliography

PB111643, CLEMENT R. BROWN, MAUREE W. AYTON, THOMAS C. GOODWIN, *and* THOMAS J. DERBY, *Library of Congress, Technical Information Div., paper-bound, 8 x 10½ in., 374 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $3.*

The bibliography includes references to published literature on the subject issued from 1935 through 1951. All material concerned with the scientific aspects of infrared radiation and its effects, and all technical applications with the exception of industrial heating and drying processes have been included. The infrared portion of the electromagnetic spectrum has been taken as the range from 0.8μ to over 100μ. Material on

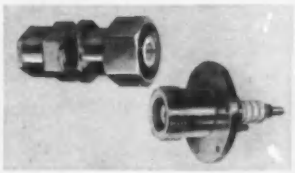
(Continued on page 402)

MEI DESIGN IDEAS

NEW!

CONNECTOR FOR TRI-AXIAL CABLE UP TO 18 KV-RMS

Essex ingenuity solved the "tri-ax" connector problem. And hundreds more. Ask Essex engineering to apply its imagination and skill to your RF connector problems.

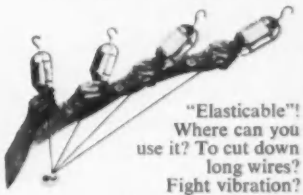


Or select from a comprehensive line of standard MIL connectors. Manufacturing follow-through delivers complete units. Modifications of standards invited. Rapid delivery.

ESSEX CONNECTOR DIVISION

NEW!

ELECTRIC CABLE
ELASTICABLE®
STRETCHES OVER TWICE ITS LENGTH! CARRIES 2 AMPS!



"Elasticable"! Where can you use it? To cut down long wires? Fight vibration? Increase portability? Improve mobility? Save space? Eliminate coils?

21 strand braided conductor. Available 1 to 6 leads, terminated with alligator clips, jacks, spades. 1000 V. insulation between conductors. Choice of covering.

UC UNITED CABLE DIVISION

MUTUAL ELECTRONIC INDUSTRIES
CORPORATION
85 Beechwood Avenue, New Rochelle, N. Y.
NEw Rochelle 6-3000

ALABAMA WIRE

Alawire—aluminum wire drawn to your specifications — from .375″ to .187″ to .064″ to .010″ or **any** diameter in between. Alawire, available to you in any alloy and finished in any temper, is shipped on fifteen pound spools (as shown) or two hundred pound drums as desired.

For further information or quotation, please write, wire or phone —

ALABAMA WIRE CO., INC.

TERRACE STREET • P.O. BOX 562 P • FLORENCE, ALABAMA

Phone 3178

MANUFACTURERS OF METAL-MESH INSECT SCREENING

heat transfer theory and processes, as such, and most material of a popular nature, have been excluded.

The large volume of literature on infrared made it impossible to bring the bibliography to a more recent date. However, infrared literature for the years 1935-1951 has been thoroughly covered.

Physical Metallurgy and Heat Treatment of Titanium Alloys

RICHARD J. MCCLINTICK, *Metallurgist;* G. WILLIAM BAUER, *Metallurgist;* LEE S. BUSCH, *Director of Research of the Mallory-Sharon Titanium Research Laboratory;* 9¾ x 6¼ *in., 60 pp. Published by Navy Bureau of Aeronautics, Washington, D. C.* $1.

It is the purpose of this report to define and clarify titanium alloy heat treatment for the benefit of both producers and fabricators. The body of the report consists of three major subject headings: theory of hardening, annealing, and hardening. The latter two major subjects are subdivided into the three alloy types: alpha, martensitic, and metastable beta alloys. A detailed subject index and reference section are included.

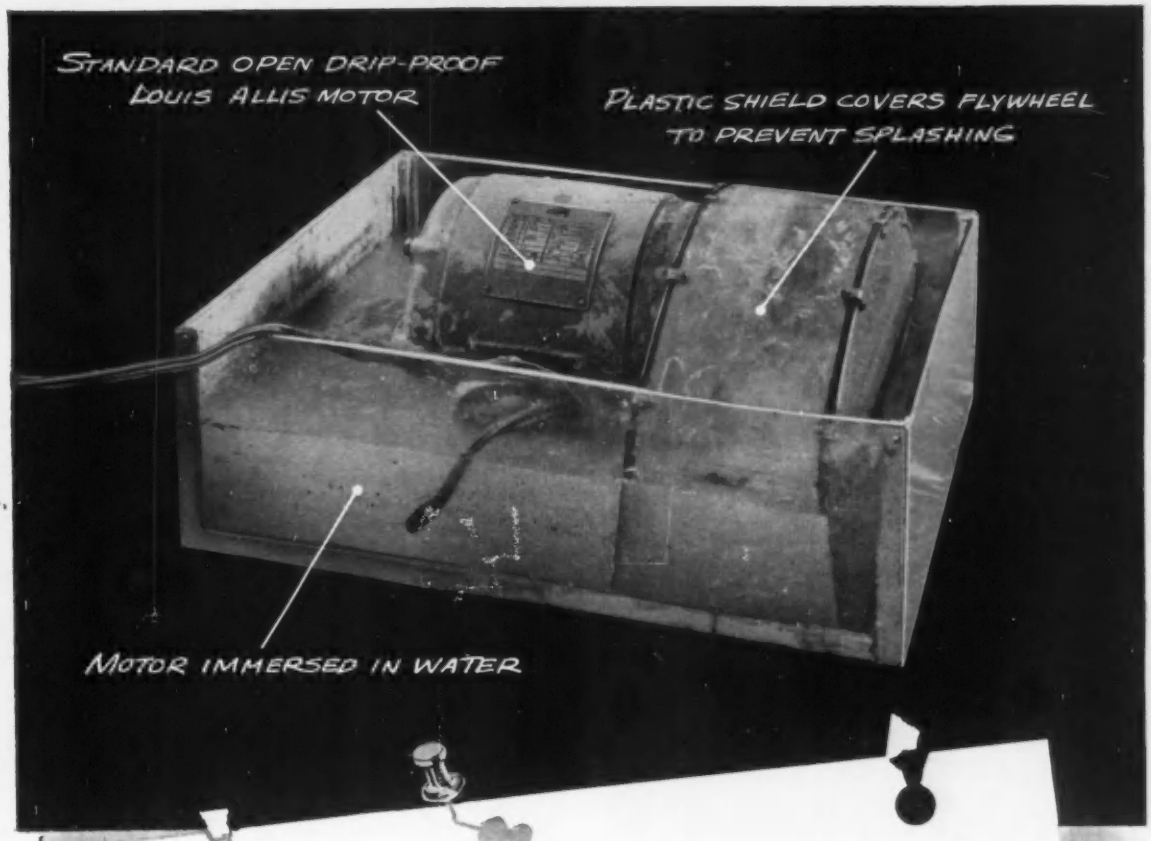
Printed Circuits NAer 00686

PB 100950, National Bureau of Standards, Engineering Electronics Section, paper-bound, 8 x 10½ *in., 63 pp. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.* $1.75.

The Dept. of the Navy, Bureau of Aeronautics authorized the National Bureau of Standards to evaluate and develop techniques for printing electronic circuits and subassemblies for airborne use. A summary is made here of techniques, materials, and component parts in the design of printed circuits. Many new concepts and techniques are used.

A miniature high-gain, wide-band I-F amplifier with performance characteristics generally useful in airborne equipment was chosen to guide development activities and to illustrate feasibility of production techniques.

(Continued on page 405)



In water 1½ years...still running

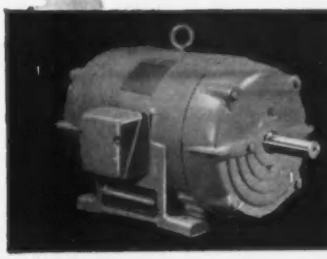
Dramatic proof that Louis Allis motor insulation provides unusual moisture resistance

We wouldn't do this to a motor. But somebody did, to check our new insulation. They took a standard open drip-proof motor, placed it in water up to the shaft, and ran it a year and a half.

The motor will still run, too, which proves that our insulating materials are of top quality. One of our exclusive features is the new phenolic impregnating varnish we use. As you can see, this varnish resists moisture, but it also has excellent thermal and chemical resistance and is not susceptible to embrittlement.

Insulation usually determines the life of a motor. That's why the insulating materials used in the new L. A. line are the product of years of continuous research and development. That's why Louis Allis motors run longer . . . give less trouble.

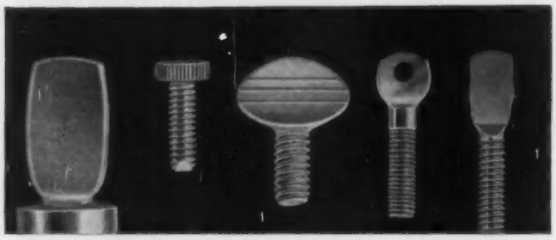
Find out the many other advantages available to you in the new L. A. line of motors. Write for our new bulletin No. 1700.



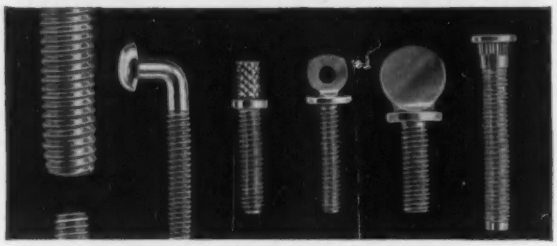
A complete line of standard rerated motors in frames 182 through 326U now in stock. Special rerated motors are available on short delivery.

LA-107

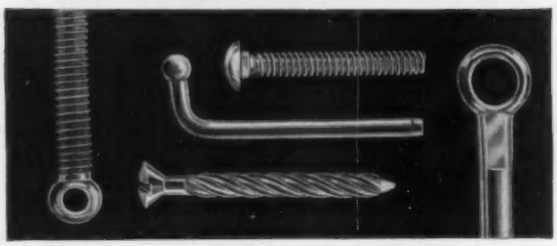
THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN



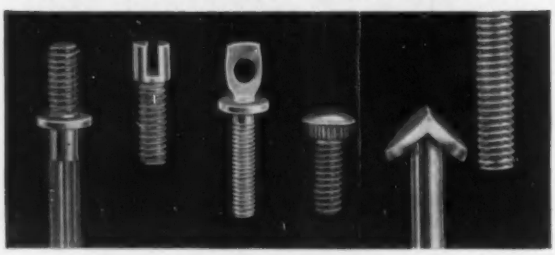
YOU CAN'T BEAT COLD FORMING



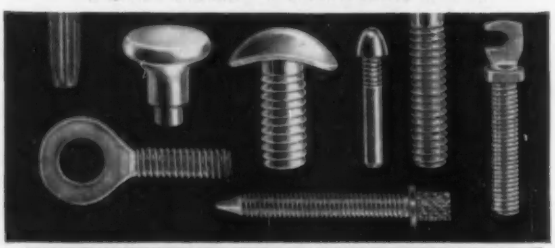
FOR PARTS LIKE THESE—AND



YOU CAN'T BEAT PROGRESSIVE



FOR COLD FORMING . . .

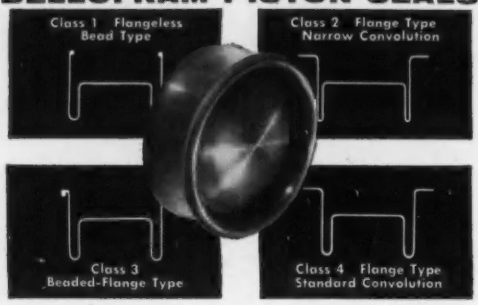


MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS
. . . INCLUDING SQUARE AND HEXAGON MACHINE SCREW NUTS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
DIVISION OF THE TORRINGTON COMPANY
48 Norwood St., Torrington, Conn.

NOW THERE ARE 4 TYPES OF BELLOFRAM PISTON SEALS


Class 1 Flangeless Bead Type
Class 2 Flange Type Narrow Convolution
Class 3 Beaded-Flange Type
Class 4 Flange Type Standard Convolution

Bellofram long stroke, constant area diaphragms are now available in *four* designs, for efficient use as piston seals in countless types of pressure-sealed mechanisms. Class 1 permits design and manufacture of smaller, lighter, lower cost mechanisms. Class 2 is specially suited to high pressure applications and limited to sizes under 2½". Class 3 allows parting surfaces at flange joint to form a metal to metal joint. Class 4 is suitable for instruments and machines having natural parting surfaces between cylinder and mating metal surfaces.

Bellofram seals are available in any of 300 standard sizes: for 1" to 6" bores; in numerous elastomer-fabric combinations from Nitrile Rubber and Nylon to Silicone Rubber and Dacron. Choice is wide, design and operating advantages many. Outline your needs in confidence.

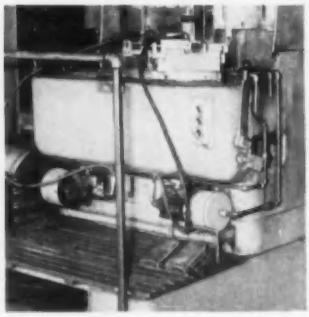
Have you a copy of the NEW 16-page Bellofram Catalog? Write today.

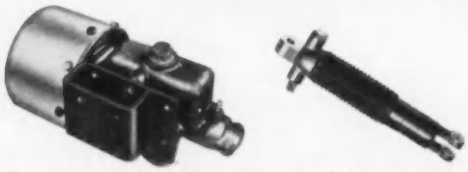
Bellofram
CORPORATION
BURLINGTON, MASS.

Let Wagner solve YOUR ACTUATION PROBLEM

Wagner Electric Corporation offers a wide variety of air and hydraulic actuators and controls.

For specific applications, Wagner can furnish engineered kits with actuators, controls, tubing, fittings —everything required for complete installation. Your nearby Wagner field engineer will get you detailed specifications on a system for your particular application. Call him today.





Shown above is a broaching machine with swivel type clamping fixtures, utilizing the Wagner power cluster which converts air pressure to hydraulic pressure that is delivered to actuating cylinders on each of the clamping fixtures.

Wagner Electric Corporation
6406 PLYMOUTH AVE., ST. LOUIS 14, MO. 156-2

Extreme compactness of design causes higher internal temperatures than encountered in conventional assemblies. Characteristics of special components and materials and construction details of final design are discussed.

The high temperature required resistors capable of operation at 200 C. A resistor tape, from which individual resistors may be cut and pressed into place in the circuit, was developed to meet this requirement. Special equipment developed for slitting and die-cutting this tape are described.

Simplicity of circuit design, use of multiple-function components, use of thin flat plates or cylindrical forms as printed circuit base designs, and other special problems involved in the adaptation of printed circuits to machine production are discussed.

Operation of a printing press for printing circuits on cylindrical shapes is fully described and possibilities of adapting it to automatic operation are explored.

A proposed program of further areas of printed circuit development is presented.

The Measurement and Evaluation of Luminous Material

PB 111785, 8 x 10½ in., 58 pp, paperbound. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. For price write J. E. Wheat, Chief, Newsletter Section, Dept. of Commerce, at above address.

This report gives an account of the origin and growth of the interest in phosphorescent and fluorescent material and describes the development of applications to aid military activities, together with procedures and instruments for evaluating the properties of such material. The levels of luminance encountered in the use of luminescent material are given and the various units of measurement that have been used are defined. The development of both the visual and photoelectric low-luminance photometers and methods for use are discussed.

Over the period which is covered in this report the luminance attained by radioactive self-luminous material has been increased from 10 to 15 times with further increase definitely in

(Continued on page 406)

FOR ACCURATE PUMPING

Halliburton Oil Well Cementing Company uses VIKING PUMPS

"The fact that Viking Pumps will consistently deliver in direct proportion to their speed makes them a valuable asset to our sand proportioner units," Halliburton comments.

Used as metering pumps, Vikings deliver fluid into the mixing tank of the unit, where it is properly blended with the correct amount of sand for hydraulic oil well fracturing service. It is the first practical design for such work and is made possible by accurate Viking pumping. From one to four Viking 450 G.P.M. at 260 R.P.M. pumps are used with Halliburton equipment.

If you have a problem where metering, blending or other accurate pumping of liquids is concerned, let Viking help you solve it. Write for information and Bulletin 56Sx.

VIKING PUMP COMPANY Cedar Falls, Iowa, U.S.A.
In Canada, it's "ROTO-KING" pumps
THE ORIGINAL "GEAR-WITHIN-A-GEAR" ROTARY PUMP

RAWSON

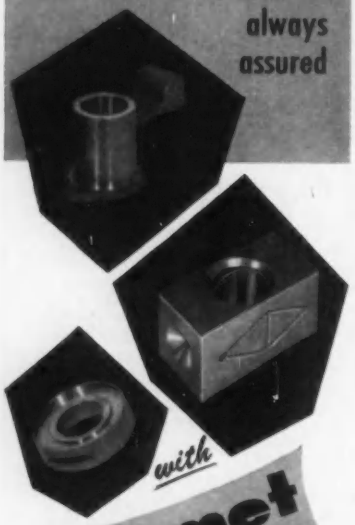
4 PURPOSE COUPLING

Rawson Couplings will enable your motors to start heavy loads in seconds, keeping down your electric power demand charge. Made up to 1000 h.p. Simple in action; effective in service. Rawson is a 4-purpose coupling—transmitting smoothly loads between motor and machine—hundreds of applications—*Starts . . . couples . . . cushions . . . limits load.*

RAWSON COUPLING DIVISION
O. S. WALKER CO. INC. WORCESTER, MASSACHUSETTS

Highest Quality Machining

to precisely controlled tolerances is always assured



with

Promet Engineered Bronze

BEARINGS · BUSHINGS
WEARING PARTS

—just as you are also guaranteed superior service or your money back.

DIFFICULT OIL GROOVING

. . . smooth grooves, even around acute bends . . . no sharp edges or burrs . . . improved lubrication because there is no "wiping" action. Available rough cast if desired.

SEND PRINTS

and condition of operation for recommendations, quotations, literature and service data sheets.

The American Crucible PRODUCTS CO.

"Bearing Specialists Since 1919"

1317 OBERLIN AVENUE, LORAIN, OHIO, U.S.A.

Please send free literature and service data sheets on Promet Bronze.

NAME_____

COMPANY_____

STREET_____

CITY & STATE_____

prospect. The useful life has been extended a matter of years. The self-luminous phosphor is now obtainable in all colors of the spectrum and the radioactive hazards have been reduced to almost negligible portions. Phosphorescent tapes, powders, and paints have been made more luminous and more durable by improved methods of manufacture and protection.

The number of uses of fluorescent material as aids to military activity under dark conditions has increased and various applications are being made of the so-called daylight fluorescence to make objects more visible against extensive backgrounds. Recent advances in the knowledge of the properties and methods of production of beta-emitting radioisotopes have opened new fields for investigation and uses for the radioactive self-luminous phosphors. Previous to about 1950 radium was thought to be the only successful exciter of phosphors; however, since that time and especially during 1954 and 1955 at least five beta-emitting radioactive isotopes have been found which are superior to radium. With more research and development this list will undoubtedly be extended. Up to the present, luminous zinc sulphide has been found to be the only practical phosphor for excitation by radioactivity. Other phosphors have too low luminosity or are rapidly destroyed.

Electrons, Waves and Messages

JOHN R. PIERCE, *Dir. of Research, Electrical Communications, Bell Telephone Laboratories. 8½ x 5¾ in., 318 pp. Published by Hanover House, 575 Madison Ave., New York 22, N. Y. $5.*

Written by one of the scientists working in electronics today, this book explains for the general reader the basic principles behind this science and shows how they are applied in technology. Starting with an examination of the laws that govern the motions of particles and waves, and using well-chosen examples to make them clear, the author goes on to discuss electric and magnetic fields. Once he has given a general background to the science, he deals with amplifiers, television,

(Continued on page 409)

Endurance Rated ELECTRIC COUNTERS and ACTUATORS to Fit every need

200,000,000 COUNT LIFE

PIC SUPER-WIZARD

1000 CPM.
5 watts input.
Balanced Armatures.
4 and 6-digit models in basemount, panelmount and dustproof enclosed types for 60, 40-50, 25 cycles and DC; all voltages to 230.

Purchase cost only 18c per million counts.

50,000,000 COUNT LIFE

PIC 600

1000 counts per minute
7 watts power consumption
Balanced armature
Quiet operation. No AC hum.
Tamper proof housing.
Lubrication not required.
Available in basemount and panelmount models—also to count dozens, for 60, 40-50, 25 cycles and DC; all voltages to 150.

6,000,000 COUNT LIFE

PIC MERCURY 4-digit Reset

600 Counts per minute.
3 watts power input.
4-digit Basemount and Panelmount models also to count dozens — all voltages to 115, AC or DC.

3,000,000 COUNT LIFE

PIC MERCURY 5-digit non-reset

600 Counts per minute.
3 watts power input.
Tamper proof construction.

See your PIC Representative or write

PIC PRODUCTION INSTRUMENT CO.

702-10 W. Jackson Chicago 6, Illinois

CORNING GLASS
BULLETIN FOR PRODUCT DESIGNERS

CORNING GLASS WORKS, 51-6 Crystal Street, Corning, New York
Please send me the following material:
☐ Booklet: "Glass and You."
☐ Bulletin IZ-1: "Glass . . . its increasing importance in product design."
☐ Information on the VYCOR brand glasses.
Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____

How to engineer a platypus

A happy combination of purposeful practicality is the furry platypus with its webbed feet, beaver's tail, and duck's bill.

A lot of our customers, to their continuing delight and profit (we hope), have discovered that glass is sort of platypus-like in that it, too, can be made to combine many useful characteristics.

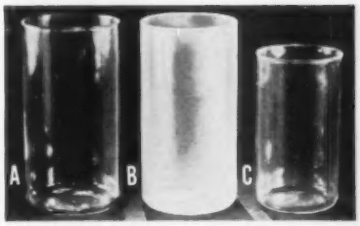
Take, for example, PYREX brand pipe. Here you see a man using a piece of it to drive a one-inch nail in a pine block. This is essentially an extra-curricular activity for glass pipe, which is more at home conveying metal-eating acids around chemical plants, but it's a way of showing just how tough glass can be when it's *made* that way.

All of which may serve to illustrate for you how we can arrange the optical, chemical, thermal, mechanical, and electrical properties of glass in different combinations to match a considerable variety of end-use requirements. In fact, we've worked up some 50,000 different formulas for glass in our years of helping customers solve specific design and processing problems.

If platypus-like glass is a novel idea to you, if you've never given glass a second thought as a highly adaptable design and construction material, we suggest your reading a pocket-size volume entitled "Glass and You." It tells in a few words and many pictures how glass contributes to profit and pleasure and we'd be delighted to send you a copy. Or, if you're more concerned with putting glass to work for you than in learning what it's doing for others, there's a slightly more technical bulletin called, "Glass—its increasing importance in product design." We'll be glad to send you either—or both.

Most remarkable glass

In 1952 Philadelphia's Franklin Institute presented the John Price Wetherill Medal to Corning's Dr. Martin E. Nordberg and Harrison P. Hood for inventing the most fabulous of glasses—VYCOR brand 96 per cent silica glasses.



Evolution of a VYCOR jar: A—formed by conventional glass blowing; B—"thirsty glass"; C—finished product.

These two scientists discovered a composition that appeared to be a combination of two distinct types of glasses. One type could be dissolved out, leaving a skeleton of 96 per cent or more of silica filled with so many millions of holes that a one-inch cube contained some 60,000 square feet of hole surface.

This new child of research was dubbed "thirsty glass" because, just sitting around, it absorbed moisture right out of the air. But our researchers were on the trail of something even more exciting. They heated their "thirsty glass" and it shrank to two-thirds its original size. The millions of little holes vanished and left a vacuum-tight glass that looked like any other—except that you could take this new glass white-hot from a blazing furnace and plunge it into ice water without the slightest injury. It was a glass as ideal as fused quartz, but different since it could be melted, mass produced, and worked in its original state like ordinary glass.

If you'd like to know more, just check the coupon above.

Ribbon glass by the yard

Here's a glass that's a thousandth of an inch thin and in small widths it's flexible as—well, a ribbon. You can twist it, roll it, wrap it around your arm without cracking it. It comes in any length you want—inches, yards, miles.

Actually ribbon glass isn't a single glass. We can make it of several different compositions according to what you need it for. Originally we developed it to take the place of mica in electronic capacitors of which there are several in your radio and TV sets and in any other piece of electronic equipment you can name. As mica is formed in layers, it is subject to cleavage in the plane parallel to lamination; ribbon glass being homogenous is easily workable. This is just one advantage of this glass in capacitors.

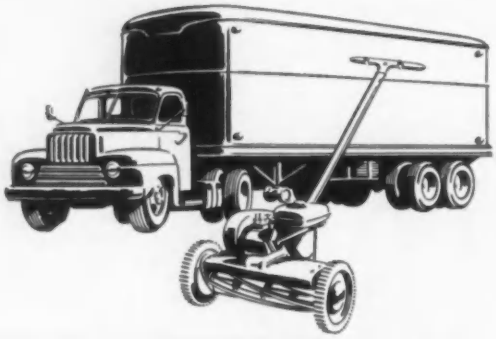
Medical scientists have found a quite different use for ribbon glass—as microscope slide covers. These are the wafer-like pieces of glass that are used to cover blood smears and the like for examination under the microscope. In this case ribbon glass can be made clearer, flatter and more free of bubbles and striae than previously made glasses.

Seems as if this unique stuff should be good for a *lot* of things, but *what* (other than electrical and laboratorial) probably lies in the laps of imaginative designers. Would you like us to send you a little strip to play with? *Customer* ideas and problems really bring out the best in glass. So, even if what's on your mind seems unrelated to any item this page discusses, glass may still be its fulfillment. We'd like to hear from you.

CORNING GLASS WORKS
CORNING, N. Y.
Corning means research in Glass

Zenith

HAS A WIDE RANGE OF CARBURETOR TYPES



TO FIT A WIDE RANGE OF APPLICATIONS!

Are you looking for an unusual size or type of carburetor? Perhaps Zenith* has the answer to your problem. For more than 35 years Zenith has been designing and building carburetors for every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines. The chances are you can use a unit Zenith is now making and avoid the cost of a specially designed carburetor.

On the other hand, if your carburetor requirements are highly specialized, Zenith's engineering experience will prove invaluable in solving questions of placement, efficiency and economy of operation. Just remember, whatever your carburetor problem, it will pay you to look to Zenith for the answer.

*REG. U. S. PAT. OFF.

ZENITH CARBURETOR
DIVISION OF **Bendix**
AVIATION CORPORATION

696 Hart Avenue, Detroit 14, Michigan

MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

Imperial

the world's finest

TRACING CLOTH

In drafting rooms throughout the world Imperial quality is the standard by which fine tracing cloths are judged. This has been true for decades, and Imperial remains the finest tracing cloth because its makers have continued to improve its quality and value.

HEYCO NYLON STRAIN RELIEF BUSHINGS CUT PRODUCTION COSTS AND IMPROVE PRODUCT QUALITY

Approved

With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly enhanced.

HEYMAN MANUFACTURING COMPANY
Kenilworth 3 New Jersey

HEYCO

Send wire sizes for free samples and specifications.

radiation, microwave systems, and the most important problems that scientists face in electronics. There are chapters on communication theory and noise, on relativity and the future of electronics.

Research Investigation of Magnetostrictive Techniques For Obtaining High Frequency Vibrations

PB 111777, 8½ x 11 *in.*, 222 *pp, paperbound. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $6.

The need for a vibration exciter for turbine and compressor blading vibration research in the 10 to 30-kc frequency range is pointed out. It is shown that a magnetostrictive or crystal transducer in conjunction with an exponential probe should give sufficient amplitude to cause failure stresses in turbine blades if the apparatus is tuned, by construction, to the blade frequency. Design and construction of a magnetostrictive stack, exponential probe, displacement pickups and an amplifier is discussed. Proposed tests of the apparatus are outlined.

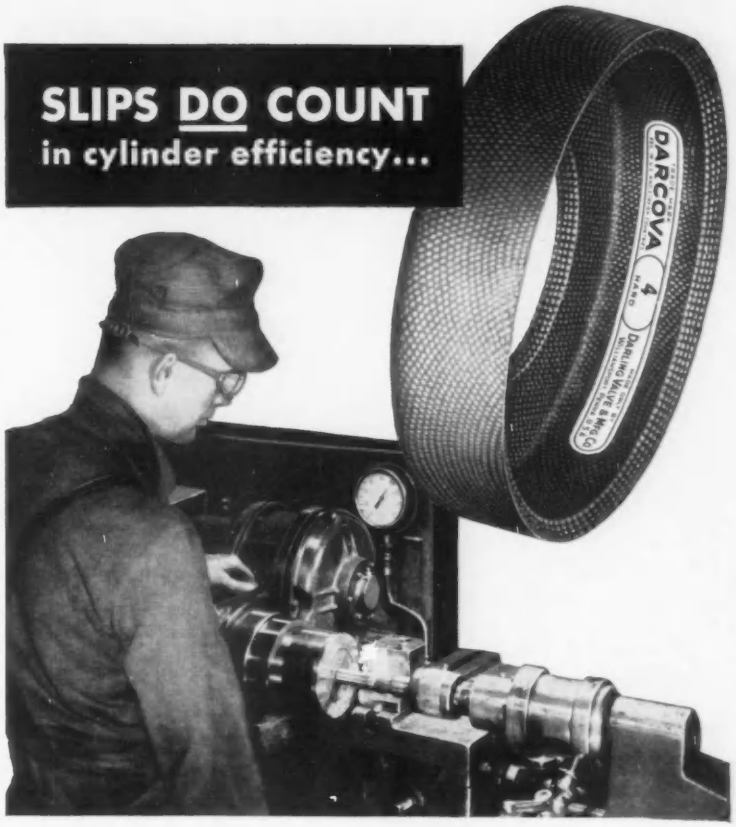
Engineering Properties of Commercial Titanium Alloys

PB 111981, M. W. Mote, Jr. *and* P. D. Frost, *paper-bound,* 11 x 8½ *in.*, 90 *pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.* $2.25.

This report presents the known reliable mechanical and physical properties of the titanium alloys with recognized commercial significance as of mid-1955. All of the data reported were obtained directly from the four producers of the nine alloys discussed and are the most recent data available. The great volume of data developed in detailed studies by fabricators and research organizations is not included in this report.

The room-temperature properties of mill-annealed stock, as listed in this report, can be of immediate and direct value to design engineers. The listed room-temperature properties of commercial stock after selected heat treatments are not so firmly established,

(Continued on page 410)



Now, cost-conscious engineers are standardizing on **DARCOVA PUMCUPS!**

Reason—On all types of air and hydraulic controls and mechanisms maximum volumetric efficiency is assured with Darcova Pumcups. Moreover, Pumcups outlast ordinary packing at least 3 to 1!

CHECK THESE OTHER ADVANTAGES TOO!

- Reduced operating speeds
- Fewer shutdowns
- Smoother operation
- Lower power costs
- Longer cylinder life
- Closer control

If your slippage is showing, write for Bulletin No. 4502 on Darcova Pumcups for air and hydraulic mechanisms . . . or Bulletin No. 4401 on Pumcups for reciprocating pumps.

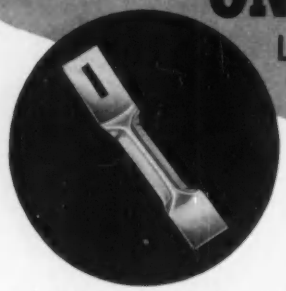
DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

PUMCUPS

750,000 "ON AND OFFS"

Leading appliance maker chooses miller phosphor bronze for range switch part



Miller Phosphor Bronze is consistently chosen for the tough jobs—in this instance a switch part that must withstand an estimated 750,000 "on and offs" without fatigue or fracture. Miller *specializes* in the tailor-made production of phosphor bronze alloys—in strip, coiled and flat lengths—best fitted to your needs. At Miller, Phosphor Bronze is the main line, *not* a sideline.

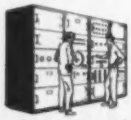
THE MILLER COMPANY • MERIDEN, CONN.
ROLLING MILL DIVISION
America's Quality Phosphor Bronze

miller
SINCE 1844

for DEPENDABILITY
SAFETY
ECONOMY

Ball-lok® pins

Wherever units are frequently assembled or disassembled, BALL-LOK pins save costly man hours lost in handling assembly tools, nuts, bolts, washers, etc. BL-SB push button pins are *safe* . . . operator must first push release button then pull pin.



WRITE FOR FREE, ILLUSTRATED SPECIFICATIONS BROCHURE.

mfgr. D. W. Price Corporation

sales representative

ROWE SALES CO.
2140 Westwood Blvd., Los Angeles 25, Calif.

Over 85% of the torque wrenches used in industry are

STURTEVANT
TORQUE WRENCHES
Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams...inch ounces...inch pounds ...foot pounds
(All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

PA STURTEVANT CO
ADDISON (QUALITY) ILLINOIS

but indicate possible higher-strength ranges for projected designs. The same qualification applies to the listed elevated-temperature properties; the values are examples but not design allowables. Additional supporting data, especially on elevated temperature strength and stability, and on heat-treatable alloys, are needed. It is to be anticipated that an early revision of this report will be required.

High Temperature Technology

Edited by I. E. CAMPBELL, *Battelle Memorial Institute.* 6 x 9¼ *in.*, 526 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.* $15.

This monograph is intended both to acquaint the reader with recent developments in the field and to indicate the importance of established techniques and materials to modern high-temperature technology. In general, consideration is primarily given to service at temperatures above 1500 C. However, much of the processing of materials for service at these temperatures is done at considerably lower temperatures and, therefore, particularly in the materials and methods section of the book, much of the discussion relates to processing at moderate temperatures.

The book is divided into four sections: an introductory section tracing the development of modern refractories and modern high-temperature techniques; a materials section; a methods section; and a measurements section.

A Review of Air Force Materials Research & Development Program

PB 111537, 8½ x 10¾ *in.*, 138 *pp, paper-bound. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $3.75 *and* $2.75.

This report was prepared by Wright Air Development Center to summarize the major research and development effort of the Air Force in the field of materials over the past decade. Abstracts of WADC Technical Reports for the period July 1, 1951, to June 30, 1953, are reports published

(Continued on page 413)

Never before on a Power Plane... a motor that spins at 25,000 RPM!

CASE HISTORIES FROM MT. VERNON FILES

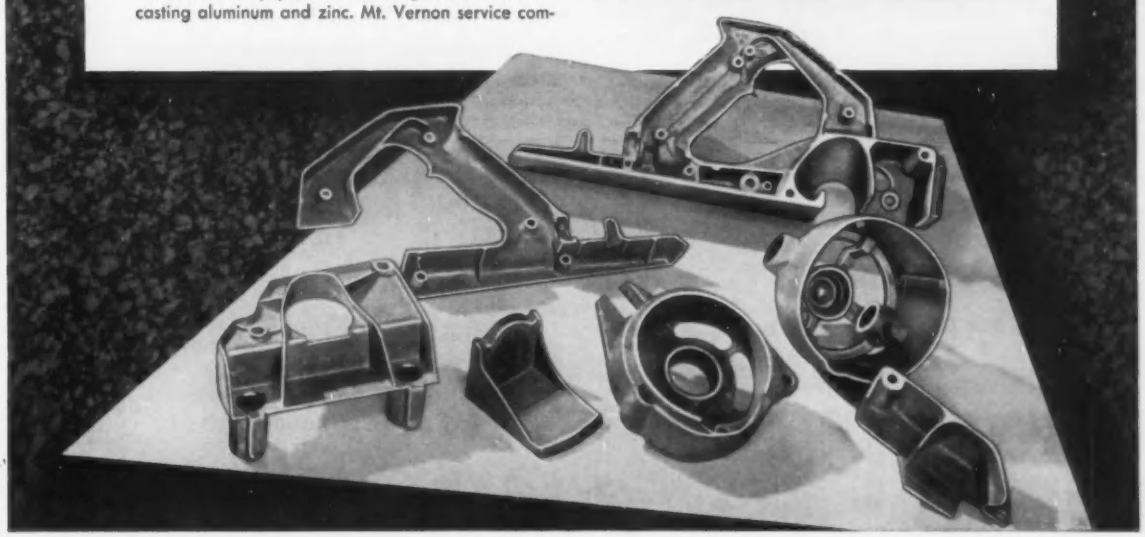
No power plane before this Porta-Plane has ever used such a high speed motor. And when any manufacturer is out to break all precedents, and still sell his product at a low price, he needs every bit of designing and production skill he can find—anywhere.

This manufacturer found these in generous abundance at Mt. Vernon. The 8 principal parts of the frame of the Porta-Plane were designed to obtain the special advantages of die casting: thin wall sections of great strength and rigidity, negligible machining, smooth finish, high speed production, low cost.

This important advantage—low cost—stems directly from the way we are organized here at Mt. Vernon. From die cast to finished casting, Mt. Vernon has both the complete die casting service and the facilities it takes to produce parts like these at minimum cost in any quantity. We have 162,000 square feet of the most modern equipment for making dies and for die casting aluminum and zinc. Mt. Vernon service comprises completely coordinated designing, die-making, casting, and machining, all under one roof.

It will pay you to bring your production specifications to us. We may show you, as we did Porter-Cable, the way to important cost reductions and improved products.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



OK

CUSTOM MOLDED

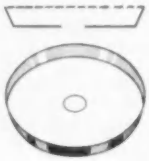
TEFLON

(Du PONT TRADEMARK)

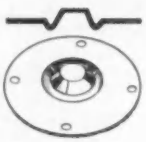
IN THIN SECTIONS AND SHAPES . . .

CAN IMPROVE PRODUCT PERFORMANCE AND CUT REPLACEMENT COSTS

TEFLON is not a substitute for rubber, leather, or other sealing materials . . . TEFLON is in a class by itself, and there is no substitute for quality and performance.



TEFLON has a combination of chemical, electrical and mechanical properties unmatched by any other single material. Such characteristics as chemical inertness, resistance to corrosion, high heat resistance, toughness, high dielectric strength, low co-efficient of friction offer you design and product-improvement opportunities never before possible.



To evaluate "Teflon" for your own use . . . without cost or obligation,

SEND FOR FREE BROCHURE—

"SPARTA REPORTS ON TEFLON"

"DEPT. PE"

The First Cost Can Be the Least . . . If It Is The Last Cost!

IMPORTANT!

As an added service to YOU, Sparta can now fill your requirements for

TEFLON FLEXIBLE THIN WALL & SPAGHETTI TUBING

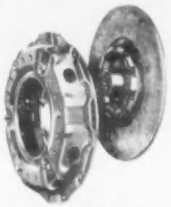
SPARTA MANUFACTURING CO.
DOVER, OHIO
Phone: 4-2755

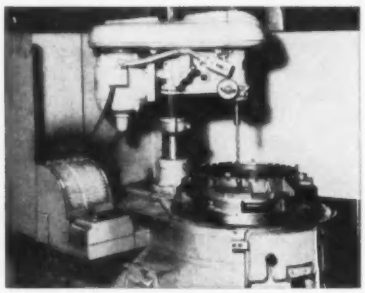
ROCKFORD

MEMO— Clutch must have accurate balance

All ROCKFORD clutch plates not only are carefully checked for accuracy of dimensions, but are inspected on an electronic balancing machine.

SPRING LOADED





Uniform operation, minimum wear, less frequent adjustment and long life qualities of ROCKFORD CLUTCHES thus are protected during production.

Let our engineers show you how ROCKFORD quality safeguards insure low maintenance for ROCKFORD clutch equipped machines.

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

B. W. ENGINEERING MAKES IT WORK

ENGINEERING B-W PRODUCTION

B. W. PRODUCTION MAKES IT AVAILABLE

ROCKFORD
Clutch Division
BORG-WARNER
209 Catherine St., Rockford, Ill.

CLUTCHES

in the areas of metallurgy, textiles, petroleum products, structural materials, rubbers, plastics, packaging, protective treatments, analysis and measurements.

Supplemental, PB 111648—Technical reports (130 of them) issued during the period July 1, 1953—June 30, 1954 are abstracted. Also listed are 17 reports issued during June 1, 1951-June 30, 1953, which were not included in WADC Technical Report 53-373.

As a final summary, a numerical index of all the technical reports issued during the period Aug. 1928-June 1954 is provided.

Investigation and Development Of High-Temperature Structural Adhesives

H. N. Homeyer, Jr., J. H. Preston, K. L. McHugh; *Connecticut Hard Rubber Co.* 10½ x 8¼ *in., paper-bound, 112 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.* $3.

This report describes the investigation and development of structural adhesives from silicone materials for high temperature service conditions such as are encountered in certain aircraft operations. The results of lap-shear tests on aluminum-to-aluminum specimens bonded with a large number of silicone resins, rubbers, copolymers, and experimentally compounded mixtures are reported. The data presented shows that adhesives with considerable strength can be obtained and that the target objectives, although not yet reached, are not beyond the realm of possibility. It was found that shear strengths averaging over 2000 psi at 70 deg F, 700 to 900 psi at 300 deg F, and 400 psi at 500 deg F, can be obtained with unmodified resins.

A study of certain silicone-organic copolymers has shown that silicone-alkyds and epoxies produce strong aluminum-to-aluminum bonds at moderate temperatures. They have the drawback of being thermoplastic, the same as the pure silicones do.

A study of fillers and polymerization catalysts as modifiers for silicone resins and copolymers has shown improvement in elevated temperature shear

(Continued on page 414)

Cambridge

WOVEN WIRE CONVEYOR BELTS take the "hot spots" out of ANNEALING & BRAZING

FREE CIRCULATION of heat and gases through the all-metal belt and around the work permits continuous, uniform heating and cooling as work moves through your plant.

By combining controlled movement with free circulation of process atmospheres, Cambridge Woven Wire Conveyor Belts eliminate batch annealing and brazing. There is no formation of "hot spots" which produce local stresses. Continuous, belt-to-belt flow through subsequent quenching and washing operations as well as heating, cuts costs and provides fast, uniform production.

REGARDLESS OF YOUR INDUSTRY...

. . . metalworking, food, chemical, glass and ceramic . . . whether the machines are for your own operation or resale, you'll find "free circulation" only one property of Cambridge belts that makes combined movement and processing practical and economical. Open mesh construction also provides rapid drainage of process solutions. Belts are corrosion resistant and impervious to heat damage, even at 2100°F. They have no seams, lacers or fasteners to wear more rapidly than the body of the belt. Cambridge Woven Wire Belts are made in any size, mesh or weave; from any metal or alloy. Special surface attachments are available to hold products during inclined movement.

Call in your Cambridge FIELD ENGINEER to discuss how you can cut costs by continuous operation. Look under "BELTING, MECHANICAL" in your classified phone book. OR, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

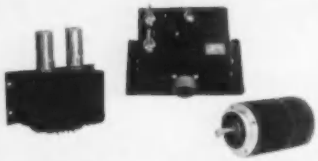
Department P, Cambridge 6, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

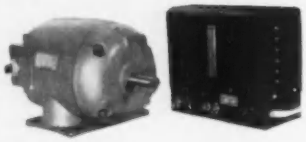
Infinitely Adjustable

AC SPEED CONTROL SYSTEMS

FOR INSTRUMENT—



OR INDUSTRIAL—



APPLICATIONS

WacLine Power Systems provide the economical answer to speed control of AC motors under variable or constant-torque applications. Speed is infinitely adjustable over a wide range. Close regulation is readily accomplished even under varying torque. The WacLine system may be applied to single or multi-phase sources on any frequency from 50 to 1000 cycles. Special features such as Program Control, Voltage Signal Response or independent adjustment of forward and reverse speeds are available.

Full Regulation with all the Advantages of AC Motors

- From .1 oz/in. to industrial power requirements.
- Longer Motor life with less maintenance.
- Permits the use of open or hermetically sealed motors.
- Applicable to explosion proof motors.
- Equally effective for large and small power requirements.
- Simple electronic principle, patent-pending.

For further information write:

WacLine, INC.,
35 SOUTH ST. CLAIR STREET,
DAYTON 2, OHIO

Mfrs. of Speed Control Systems—Dummy Loads
Microwave Components—Test Equipment
Photographic Equipment—Medical Equipment.

strengths in some cases. Tetra butyl titanate and tetra isopropyl titanate were the most effective catalysts. Aluminum dust, Celite, Santocel, and titanium dioxide fillers improved shear test values in some particular cases.

Evaluations of commercially available silicone rubber-based adhesives have shown Dow Corning's X6719-A to give the highest shear strength in bonding aluminum, over 700 psi at 70 deg and 200 psi at 500 deg F. Mixtures of silicone resins with silicone rubbers as structural adhesives have not proved successful.

Extensive evaluations of primers and metal surface treatments such as anodizing in preparation for bonding with both resins and rubbers has resulted in shear strengths about equal to control samples. In some instances, Connecticut Hard Rubber's 260, silane primer, and Dow Corning's 796, containing orthosilicate, were beneficial for bonding with X6719-A. In one case, anodizing aluminum surface to be bonded brought improvement in a silicone resin bond.

Economic Geography of Industrial Materials

Edited by ALBERT S. CARLSON, *Prof. of Geography, Dartmouth College. 7 x 10¼ in., 494 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $12.50.*

This is a handbook written by men actively employed in each industry, discussed and carefully edited by other authorities. It presents up-to-date information needed for understanding the operation of a given industry and suggests the path of future growth. The economic, technological and geographic conditions of each industry treated are explained and analyzed to show industrialists, bankers, engineers, researchers, teachers, and students in economics, geography and business, the combination of factors that determine its present and future location and subsequent potential.

Chapter One provides a description of the world distribution of the basic resources and population, and of the economic and demographic conditions under which all industry operates. Chapter Two describes the vital part transportation plays in production and

(Continued on page 417)

NEW APPLICATIONS AND SAMPLES OF INDUSTRIAL FELT*

*made to S.A.E. and Federal Govt. Specifications

SEND FOR YOUR FREE COPY TODAY!

CONTINENTAL FELT fills hundreds of jobs daily.

Ask for booklet P1

CONTINENTAL FELT COMPANY.
22-26 WEST 15th STREET NEW YORK 11, N. Y.

Strataflo

ALL POSITION
Check Valves

WITH THE FAMOUS FLEXIBLE METAL POPPET

CAN'T LEAK • CAN'T STICK

For rugged service... cold or hot water or steam. Sensitive. 200 lbs. pressure. Also available with Noiseless Rubber Poppet. Seven sizes. Write today for Bulletin 201.

Order from your jobber.

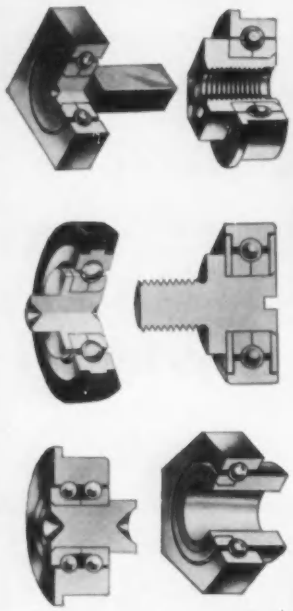
STRATAFLO PRODUCTS, INC.
FORT WAYNE, INDIANA

if it's worth engineers' time . . .

. . . it's worth engineered wire

Belden
An ever-increasing number of insulations for an ever-increasing number of electrical and electronic products puts growing emphasis on specialized wires engineered for the job. Your engineered product merits Belden wire engineering service.
LEAD WIRE by
Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO
4-L

Magnet Wire • Lead and Fixture Wire • Power Supply Cords, Cord Sets and Portable Cord • Aircraft Wires • Welding Cable
Electrical Household Replacement Cords • Electronic Wires • Automotive Replacement Wire and Cable



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

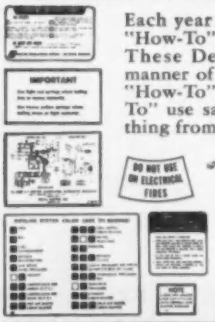
Distributors in All Principal Cities *Catalog on Request*

KILIAN MANUFACTURING CORP.

SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES:
Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

"How-To" DECAL Nameplates by MEYERCORD



Each year Meyercord produces millions of "How-To" Decals . . . in hundreds of designs. These Decal Nameplates, applied to all manner of machines and equipment tell users "How-To" use high tension equipment, "How-To" use safety masks, "How-To" start everything from lawnmowers to diesels, "How-To" operate farm equipment, "How-To" use factory lift trucks and conveyors. Make certain your product is operated correctly for maximum service and satisfaction . . . show them "How-To-Do-It" with Meyercord Decal Nameplates.

Ask for the Meyercord full color, informative "Mark It" Manual . . . just drop us a line on your company letterhead.

THE MEYERCORD CO.

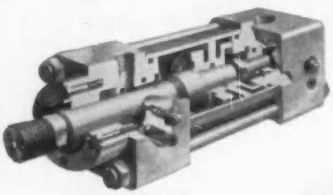
World's Largest Decalcomania Manufacturers

DEPT. T-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

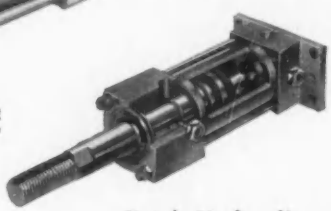
PETCH CYLINDERS

meet J.I.C. & NC-1 STANDARDS *providing*

"MOTOVATION for AUTOMATION"



☐ **TIE-ROD Design**
Low Pressure Hydraulic 500 psi—1½"–10" bores; High Pressure Hydraulic 1500 psi 1½"–6" bores; Air 200 psi—1½"–10" bores



☐ **AUTOMOTIVE**
heavy duty AIR
200 psi—1½"–6" bores

Petch Hydraulic Devices include:

☐ **BOOSTERS**
Drive Cylinders 4", 5", 6", 8" bores Ratios 5:1 to 28.5:1

☐ **TANKS**
4"–10" bore sizes

☐ **HUPP Threadless Sub-Plates — Inserts & Swivel Fittings**

☐ **Limit Switch Actuator**

☐ **Oil Tank Sight Gauge**

Send for catalog regarding the product or products for which you have use—each one includes complete specifications and engineering data. The complete PETCH portfolio consists of 96 pages of hydraulic and pneumatic information.

PETCH Pmc

469 York, Detroit 2 **MANUFACTURING COMPANY**

distribution. Key industries are discussed in succeeding chapters, from fuels and raw materials to finished products. In every case emphasis is placed on location factors essential for efficient operation.

Reliability Factors for Ground Electronic Equipment

KEITH HENNEY, *Editor-in-Chief.* 11¼ x 8¾ *in.*, 248 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $7.50.

How to improve the reliability of electronic equipment provided for our armed forces is the subject of this book. With war experience indicating that 50 to 60 per cent of equipment delivered to the field was found damaged on arrival or became unserviceable in storage, a thorough program of investigation involving a number of governmental and private agencies was set up.

This program has developed a number of workable criteria to aid the equipment designer in improving reliability. This book is the first public document offering statistics of unreliability, reasons for present poor reliability, and many techniques for improving reliability.

The book covers useful fundamentals of statistical methods, electrical and mechanical engineering principles, the human-engineering side of the problem, broad principles governing the selection and use of component parts and tubes, comments and data on training, service manuals and maintenance.

Design Manual for Roller and Silent Chain Drives

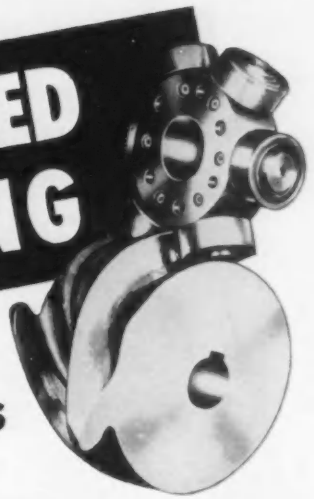
8½ x 11 *in.*, 95 *pp. Available from Association of Roller and Silent Chain Manufacturers, 7601 Central Ave., c/o Morse Chain Co., Detroit 8, Mich.* $3.50.

This design manual is sponsored by the Association of Roller and Silent Chain Manufacturers, whose objectives are "to develop and promote standards of sound manufacturing and engineering practice."

The contents and arrangement of

(Continued on page 419)

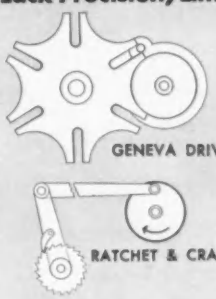
HIGH SPEED INDEXING



UP TO 1,000 PRECISION INDEXES PER MINUTE *with the*

FERGUSON DRIVE!

Geneva Drives and Other Obsolete Indexing Devices Lack Precision, Limit Production and Wear Excessively...

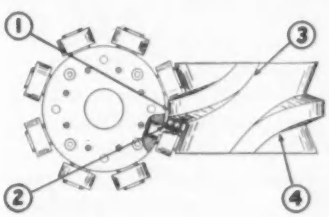


Geneva drives have abrupt acceleration characteristics. When operated at high speeds to correspond to the capacity of the rest of the machine, the tremendous shock of the sudden starts and stops soon wears out the drive and other parts of the equipment and causes vibrations and backlash that effect product quality. The plain fact is: *geneva drives limit the production of many otherwise modern machines!*

Ratchet and crank mechanisms have almost instantaneously applied accelerations. Speeds must be kept down to hold dynamic forces within limits. Even with strong auxiliary braking action, overtravel is extreme and accuracy very poor.

Of all types of indexing devices, only the Ferguson Drive has all the advantages of high speed, precision, low maintenance and design versatility!

HERE'S WHY THE FERGUSON DRIVE DOES WHAT NO OTHER INDEXING MECHANISM CAN DO . . .



1. .001" Precision; Zero Backlash

Preloaded ball bearing followers roll along tapered sides of hardened and ground cam rib. Two rollers are in contact with rib at all times. While in "rest" position, followers are engaged and locked with zero backlash by straight portion of rib. No auxiliary locking is required. *Built-in precision permits operation at maximum speed.*

2. Lower Maintenance

Ferguson Drives are rated for a minimum of 8,000 hours precision operation. When finally necessary, the Drive may be renewed for a like period by replacing standard ball bearings. *Cams have been in use for 25 years with no signs of wear!*

3. High Speed Indexing

Selection of movement and timing are independent. "Wasted" rest time can be utilized. Movement time can be reduced. *Modified trapizoid acceleration permits operation at speeds up to 1,000 indexes a minute without effecting the Drive, machine or product adversely!*

4. Reduced Vibrations

The modified trapizoid acceleration gives smooth starting and stopping, with minimum shock and vibration. In many cases where the Ferguson Drive has replaced a geneva drive, production has increased as much as 100%. *The Ferguson Drive may do this for your production machinery, too!*

Write for Catalog of Stock and Standard Ferguson Drives

ferguson

FERGUSON MACHINE & TOOL CO., INC.

ROLLER GEAR DIVISION, DEPT. 8-6 P. O. BOX 5841, ST. LOUIS 21, MO.

ENGINEERS...LOOK TEN YEARS AHEAD!

A Douglas engineer lives here

Will your income and location allow you to live in a home like this...spend your leisure time like this?

They can...if you start your Douglas career now!

Your objectives are probably high professional standing, good income, good security and good living. All four can be achieved at Douglas.

Douglas has the reputation of being an "engineer's outfit," with the three top administrative posts being held by engineers. Maybe that's why it's the biggest, most successful unit in its field. Certainly it offers the engineer unexcelled opportunities in the specialty of *his* choice ...be it related to missiles or commercial or military aircraft.

You've looked around. Now look ahead...and contact Douglas.

For further information about opportunities with Douglas in Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

DOUGLAS AIRCRAFT COMPANY, INC.
C. C. LaVene, 3000 Ocean Park Boulevard, Santa Monica, California

DOUGLAS

First in Aviation

the manual are based on advice obtained from replies to questionnaires sent to colleges and professors experienced in the field of mechanical engineering. The manual therefore is useful both to practicing engineers, purchasing agents, and to engineering students and their instructors.

After a brief review of the development of chain drives since early days, the manual discusses: Manufacture of roller chain drive components; application of these drives to specific services; maintenance to ensure long service life; design and installation of an inverted tooth silent chain. Numerous sample problems are worked out throughout the book, and tables and charts are included for simplifying the selection of chains.

A Survey of Domestic Electronic Digital Computing Systems

PB 111996, MARTIN H. Weik, *Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. Paperbound, 8½ x 11 in., 271 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.* $4.75.

The engineering characteristics, logical features, operating experiences, cost factors and personnel requirements of eighty-four different domestic digital electronic computing systems are described. An analysis of the computer field, a discussion of trends and a complete glossary of computer engineering and programming terminology are included.

This material is supplemented with illustrations, systems designs, and applications. A comprehensive bibliography and a list of domestic manufacturers are also included.

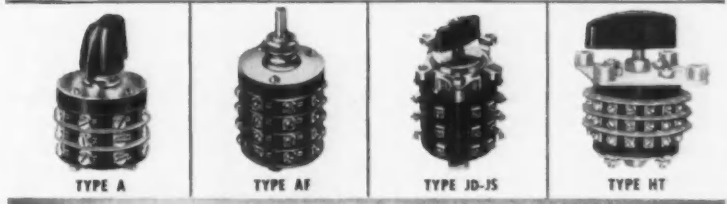
Applied Solar Energy Research

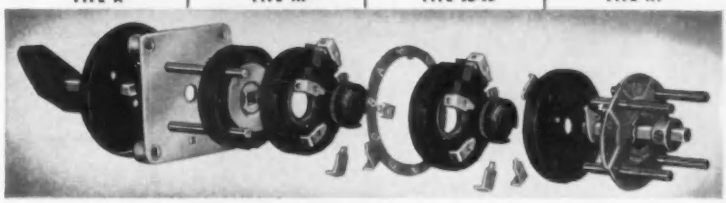
Edited by E. J. BURDA, *Dir. of Information Services, Applied Solar Energy Research, Stanford Research Institute. 5½ x 8¼ in., 298 pp. Published by Stanford Research Institute, Stanford, California. Paper-bound.* $4.

Applied solar energy research is scattered throughout most of the

(Continued on page 421)

SPECIAL SWITCHES are STANDARD with ESCO of Weymouth





When you need a SPECIAL switch . . .

ESCO standard, uniform components can be assembled to meet your requirements; or a deviation from one of our standard types will give you a special switch at a standard switch cost. *Over 90% of our production is SPECIAL in one way or another.*

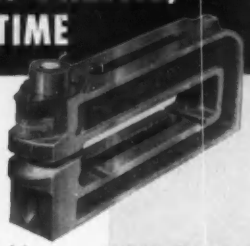
These standard switches can be modified to fit your application:

- **TYPE A** — up to 8 positions, 7 sections maximum, detent-mechanism, rating 5 amperes — 125 volts a-c/30 volts d-c.
- **TYPE AF** — up to 8 positions, 6 sections maximum, detent-action, rating with resistive load 5 amperes at 28 volts d-c or 115 volts 400 cps, per MIL-S-6807.
- **TYPE P** — Multi-section, up to 4 positions, snap-action, rating 10 amperes — 125 volts a-c, 5 amperes — 125 volts d-c, 30, 60, 100, 200 amperes at 500 volts a-c, or 250 volts d-c. Can be assembled to meet Specification MIL-S-15291.
- **TYPE JR** — up to 8 positions, 30 sections maximum, detent-action, rating 10 amperes at 125 volts a-c, 5 amperes 125 volts d-c.
- **TYPE JD-JS** — up to 8 positions, 5 sections maximum, detent-action or snap-action, rating 30 amperes at 230 volts a-c.
- **TYPE HT** — up to 16 positions, 6 sections maximum, detent-action, rating 5 amperes at 125 volts a-c.
- Bureau of Ships No. 9000-S6202-74085 rating 10 amperes at 120 volts a-c. BuShips 9000-S6202-74090, 9000-S6202-74096, and 9000-S6202-74224, ratings 30, 60, and 200 amperes, 500 volts a-c — 250 volts d-c.

Write for data sheets or catalog on ESCO rotary multipole switches — or send us your requirements and we'll give you full specifications on the ESCO switch that meets YOUR need.

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
Weymouth 88, Massachusetts

WALES
hole-punching UNITS BOOST PROFITS, CUT TIME



For PUNCHING, NOTCHING, NIBBLING jobs WALES UNITS provide an inexpensive, short cut method of die assembly set up that can be handled in a jiffy. No special tools required. No aligning necessary.

Punch from shim stock up to ¾" plate. Punches, stripping guides, springs and guide buttons are not attached to the press ram ...they're all self-contained components of the WALES UNIT.

WALES self-contained UNITS are available in infinite sizes and styles . . . from STOCK.

BL Punching Units and NA Notching Units set in place on Templet.
Punching and Notching Units with work piece in place.
Finished work pieces showing 14 punch holes and 2 notches.

Instead of a conventional set up taking nearly an hour to assemble . . .

. . . you can do the same set up in LESS THAN A MINUTE.

Use the same WALES UNITS over and over again with different hole punching patterns. No dead storage of set ups and no heavy investment.

OUR ENGINEERS WILL HELP YOU

Tell us about your job problems. We'll be happy to analyze your methods and give you constructive suggestions, without obligation.

SEND FOR BULLETIN NO. 14E

Filled with illustrations and examples of work. Information that should be worth while in your shop procedure.

WALES Strippit CORPORATION
"...the Wales-Way is the PLUS-PROFIT way"
345 PAYNE AVE. — North Tonawanda, N.Y.
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

HIGH PRECISION
magnetic clutches

featuring:

High Performance . . . very low inertia —minimum friction.

Long Life . . . minimum moving parts—no slip ring, commutators or brushes.

High Torque . . . in compact dimensions . . . up to 80 oz.-ins.

Fast Response . . . as low as 10 milliseconds.

For precision instrumentation and control applications requiring COMPACT design. Crown tooth or friction-type couplings. Single-ended, double-ended and SPDT models. New MINIATURE CLUTCH, only 1" diameter.

AVAILABLE FROM STOCK

Write for new technical Bulletin RICO-404

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORP.
A Subsidiary of Dynamics Corp. of America
203 E. 91st St., New York 28, N.Y.

HEINZE BLOWERS

Type F Blowers

Originally designed for cooling electronic tubes in transmitters, induction heaters and diathermy equipment, Heinze F-2 Blowers have become popular also for advertising displays and similar applications where a small current of air and quiet operation are required.

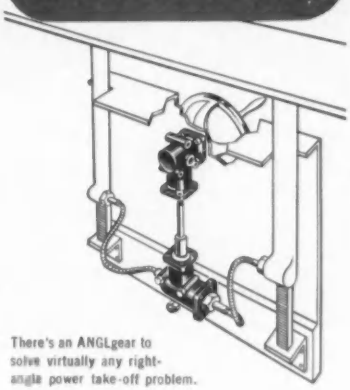
Characterized by low wattage, neat apperance and light weight. The shaded pole motor will not cause radio interference.

115v AC 60 cycles 15 watts
F2D (double) 20 CFM 3000 RPM (free air)
F2S (single) 10 CFM 3000 RPM (free air)

Heinze Electric Co
685 Lawrence Street, LOWELL, MASS

ANGLgear

RIGHT for right angles!



There's an ANGLgear to solve virtually any right-angle power take-off problem.

Name your industry — textile, canning, processing, electronics, chemical, packaging, petroleum, ceramics, metal fabricating. It's bound to be one in which ANGLgear power take-offs have solved right-angle transmission problems again and again.

Standardized ANGLgear units have won their wide acceptance because they meet design and engineering requirements fully for compactness, light weight and high operating capacity. Designed for either manual or power-operated control systems, they are available in 12 models —with ⅓, 1, or 3 hp rating, with 2-way or 3-way shaft extensions, and with either 1-1 or 2-1 gear ratio. The right-angle transmission problem that ANGLgear *can't* solve is rare indeed.

You'll find our literature in the product design file of Sweet's Catalog. Contact your local distributor, or write to us, for additional information.

AIRBORNE

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

world with occasional foci of specialized interest. There is no "Journal of Solar Science and Engineering" anywhere in the world. Reports of research investigations in this field have appeared in almost every conceivable type of scientific, technical, and semi-technical publication. Reports of scientific research on this subject extend back more than one hundred years. Communications in this field of investigation have been relatively poor and coordination of research efforts uncertain. This volume is presented as a central catalog of the current status of research on the utilization of solar energy.

Mechanical Engineering Practice

CHARLES F. SHOOP, *Emeritus Professor of Mechanical Engineering, University of Minnesota, and* GEORGE L. TUVE, *Professor of Mechanical Engineering, Case Institute of Technology.* 9½ x 6½ *in.*, 471 *pp. Published by McGraw-Hill Book Co.*, 330 W. 42*nd St., New York* 36, N. Y. $7.

A comprehensive, self-contained text and reference book written to conserve time of the practicing engineer in the field of measurement and testing. Measurement of technical and economic performance of machines and equipment is presented as an engineering assignment and attention is called to the precise requirements of the codes and standards sponsored by professional groups in the industry.

This new edition was revised to include recent trends, such as the greater use of electrical instruments and transducers and the study of dynamics of processes. New material is included in each chapter and special emphasis is placed on new techniques for automatic control, dynamic characteristics of flow and heat processes, and mechanical measurements.

Text includes: Report writing; mechanical and electromechanical measurements; characteristics of automatic controls; oils, friction, and lubrication; transfer of heat; properties of fluids; pumps and compressors; combustion and fuels; steam power generation; heating, ventilating, refrigeration and air conditioning; internal-combustion engines.

flying saucers?

NO—

stamped stove part replaced by one die casting eliminating six operations and saving 40% of the total piece cost

Stove manufacturer discovers big production advantage by having pilot light assembly produced by Paramount Die Casting Co.

Here again Paramount engineers have reproduced an already developed article by die casting methods—saving over 40% in production cost over former stamped assembly methods. Thoroughly experienced in all phases and techniques of die casting—a Paramount engineer can help you cut costs by developing original designs or redesigning your present products to the die casting process.

WRITE FOR FREE DESCRIPTIVE BROCHURE

ALUMINUM ZINC MAGNESIUM

Paramount

DIE CASTING COMPANY
ST. JOSEPH 11, MICHIGAN

LOCKHEED in GEORGIA MOVES AHEAD AGAIN!

Staff of 500 Seen For A-Plane Plant

W. R. Rhoads to Head Dawsonville Project, To Be Biggest of Its Type in Nation

Lockheed Aircraft Corp., wasting no time in the development of nuclear aircraft testing facilities at Dawsonville, announced Tuesday that W. R. Rhoads will head up the Dawsonville project.

Mr. Rhoads, who lives at 120 Osner Dr., NE, is chief staff engineer at Lockheed's Marietta plant now. He has been with Lockheed since 1941.

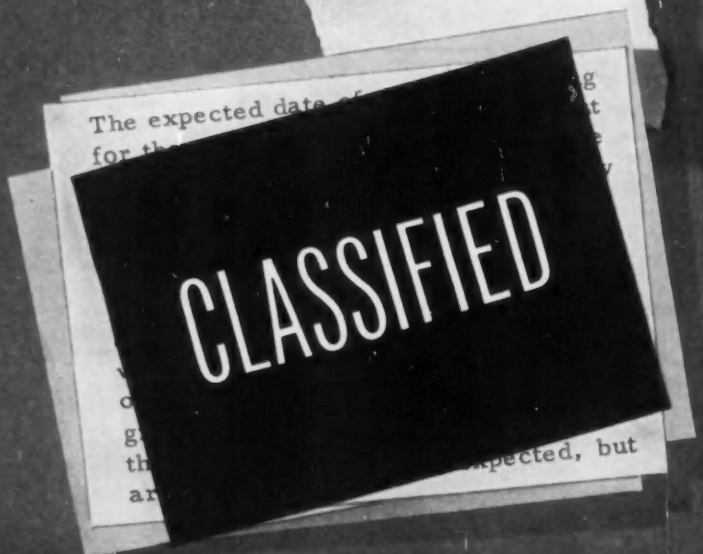
He will direct the work of the approximately 500 scientists, engineers and service personnel who will be employed at the Dawsonville site.

LOCKHEED AND the Air Force officially announced Monday night at a dinner at Gainesville that they intend to build a 10,000-acre, multi-million-dollar nuclear aircraft test site just southwest of Dawsonville (population, 350).

And, perhaps as significantly, Lockheed's top Georgia executive hinted that the actual manufacture of a nuclear-powered plane—perhaps the world's first—might take place at Lockheed's Marietta plant.

AND

there's more that can't be published—yet



The world's largest integrated aircraft plant, at Marietta, Georgia, — where we build Lockheed C-130 Turbo-Prop Cargo planes and B-47 Jet Bombers—welcomes this new Lockheed program in Georgia.

Here are projects to challenge the very limits of imagination, vision, ability and capabilities of man!

This new atomic development and its effect on the adjacent manufacturing plant and new Engineering facility at Marietta, creates far reaching additional opportunities for Engineers and Scientists in a wide range of categories in both places.

Here is a program that is literally long range in both scope and product.

Qualified Engineers and Scientists interested in becoming associated with this progressive and rapidly expanding organization are invited to inquire for further information or personal interview.

Write to

ENGINEERING PROFESSIONAL PLACEMENT

LOCKHEED

AIRCRAFT CORPORATION—DEPT. PE-6
761 Peachtree St., N.E., Atlanta, Georgia

OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

High Temperature Seals

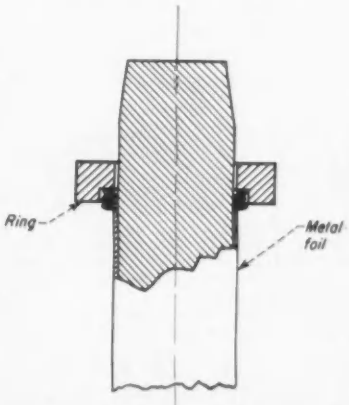
To the Editor:

The article by T. J. McCuistion of Parker Appliance Co., Rubber Products Div., entitled "High Temperature Seals" in Jan. 1956 *Product Engineering* describes labyrinth, metal foil, pressure-loaded seals for moving glands on page 155, both in the text and Fig. 16 (top). A quote from this text reads, "It can be spirally wrapped around a mandrel and then compressed into a small ring (while still on the mandrel) with many tiny loops at the top and bottom." Several associates and myself have pondered this description and Fig. 16 (top) and conclude that: (1) either it is inadequate (in extension from context) or, (2) we have failed to grasp some rudimentary concept(s). We would greatly appreciate any further clarifying data you might make available to us regarding the design considerations of, or fabrication of these seals.

—S. E. Openshaw, Jr.
San Lorenzo, Calif.

Ed—Mr. McCuistian's reply appears below:

I am attaching a rough sketch of the method whereby we have formed a few packings as described in the



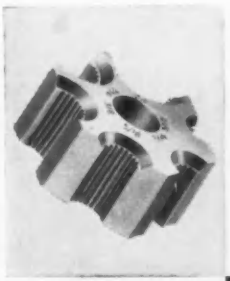
(Continued on page 425)

GIVING YOU

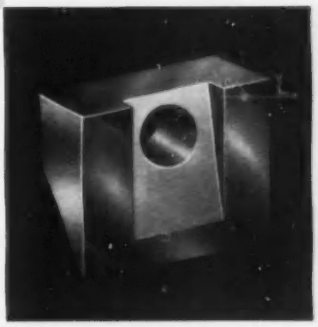
...the best and most modern!

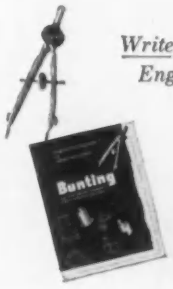
Bunting today covers a new area in the engineering and manufacture of bearings and machine parts. To the traditional line of Bunting Cast Bronze Bearings and parts is added up-to-date, soundly established facilities for engineering and manufacturing bearings and parts made of Sintered Powdered Metals.

In an entirely new plant with the very latest equipment, Bunting now attains the position in the Sintered Powdered Metals field which it has long held in the field of Cast Bronze Bearings.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.





Write to our Product Engineering Department in Toledo, or consult our nearest Sales Engineer.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

...For the first time:

Positively Leakproof HYDRAULIC PACKING

Linear VEE-DAM® rings

Here's the revolutionary, split-V-Ring design that makes other hydraulic packing obsolete! Linear VEE-DAM Rings assure absolutely leakproof performance—even without precise fitting.

★ **Sturdy rubber dams** (A) hermetically seal off center groove sections when rings are stacked together . . . eliminate labyrinth flow. **External abutments** (B) provide stabilizing support and prevent lateral leakage. Even when gaps occur at ring joints, fluid can't leak past VEE-DAM Rings.

★ Save on installation and maintenance . . . reduce down time, with Linear VEE-DAM Rings—a real achievement in hydraulic packing design! They're available in a variety of compounds to meet extremes of pressure and temperature. Get the facts now.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

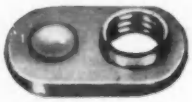
OHIO WELD NUTS

FOR APPLICATION BY PROJECTION WELDING

WS NUT For applications on rugged assemblies where it is necessary to anchor nut securely in blind location.

RN NUT OHIO'S newest weld nut with pilot and dual-line projections. Ideal in applications where tension is against the weld.

WN NUT Used where a double-end nut with a strong weld for bridging or joining two sheets or where extra strength is needed.



PN NUT Used where a pilot for easy locating, a strong weld and space limitations are important factors. Ideal for use in confined corners, flanges and narrow channels.

SF NUT Used where an extra heavy nut is needed for welding to curved surfaces or where a hermetic seal is required on a nut with a through hole.

WF NUT Used where the nut serves a mounting purpose or greater thread engagement is required than is normally provided by other type weld nuts.

WW NUT Used where a hermetic seal is required to prevent leakage of air, gas, water or dust on blind locations.

RH NUTS Used where it is desirable to have the body of the nut go through the sheet or where extra long thread engagement is needed.

FOR APPLICATION BY SPOT WELDING

SN NUT Used where assemblies are being spotwelded together and a piloted nut is required.

ND NUT Used where a large nut is needed for bridging or joining two sheets or for extra strength.

Samples and information available upon request.

THE OHIO NUT AND BOLT COMPANY

Specialists in the Manufacture of Weld Fasteners and Adjusting Screws

41 FIRST AVENUE **BEREA, OHIO**

article, "High Temperature Seals." Please note that the very close fitting metal ring tends to compress the foil into the packing described. Graphite impregnation apparently helps this type of seal to work better.

It is my hope that this is of value to you in your research efforts. However, I do wish to point out that this work has been purely laboratory experimental effort, and we are not producing any seals of this design.

This article was taken from a talk originally prepared to stimulate the thinking on high temperature seals rather than to establish design parameters for them. Apparently it is succeeding, judging the response, which is very gratifying. —T. J. McCuistion
Cleveland, Ohio

Motor Controls

To the Editor:

We wish to thank you for having published a description of our motor controls in your March issue, "New Components and Materials" section. Unfortunately, we seem to have neglected to send information on our complete line of these new controls. Besides the 3, 5 and 10 hp models you described we also manufacture units for: three-phase 5 hp/110 v, 10 hp/220 v, 20 hp/440-550 v; three-phase 7½ hp/110 v, 15 hp/220 v, 30 hp/440-550 v; three-phase 15 hp/110 v, 30 hp/220 v, 50 hp/440-550 v.
F. J. Bellac
Schrack Electrical Sales Corp.

Nomogram Scales

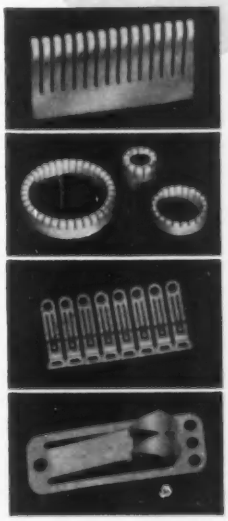
To the Editor:

Purpose of any nomograph is to save time in repeated solution of mathematical formulas, provide ease of operation, and minimize the likelihood of errors. The scales of the nomograph should cover the range of values usually encountered in the particular application.

However, the nomograph "G-Loading of Rotating Bodies," Carl Nachod, March 1956 page 219 does not fully meet these requirements. Here is a nomograph that leads to the same results but requires the construction of only one straight line instead of three lines. In addition, the scales are

(Continued on page 426)

to meet your most exacting spring specifications



For High Strength and High Endurance —specify microprocessed I-S springs of beryllium copper. These unique springs are particularly suited for applications requiring non-magnetic, corrosion-resistant properties, with excellent electrical conductivity, and stability. The inherent advantages of this ideal spring material – combined with I-S specialized engineering techniques in manufacture – assure absolute conformity to your critical spring requirements.

I-S Design Service saves you time and money! For recommendations on specific spring problems, check with I-S. Samples and short runs can be supplied quickly and economically!

For Additional Information consult Sweet's Product Design File or write for our latest Catalog.

INSTRUMENT SPECIALTIES CO. INC.
234 Bergen Blvd., Little Falls, N.J.
Telephone: Little Falls 4-0280

"MICRO ... PROCESSED" I-S BERYLLIUM COPPER SPRINGS

now available to you

STROMBERG-CARLSON

TYPE "B" RELAY

If reliable operation of a large number of contacts has application to your work, you should examine this remarkable relay, manufactured with extreme precision.

Our gang-type "B" relay can be furnished with combinations of A, B or C contacts with a capacity of up to 60 form A contacts. It will accommodate six stacks of spring combinations which, due to special construction, occupy an unusually small space and make the relay desirable for group mounting.

This relay has been for years distributed exclusively and in large numbers to the Independent telephone industry. Expanded production facilities enable us now to offer it to the general engineering world. Like all our relays, it is designed to operate under extreme ranges of temperature and humidity.

On request . . . If you will write or call, and state the application you'd plan to use it in, we'll be happy to send additional information, and a catalog of our entire relay line. No obligation, of course.

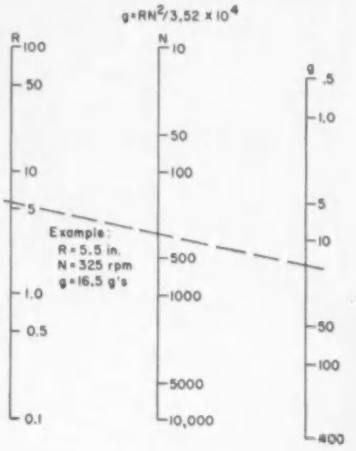
S-C
STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

TELEPHONE INDUSTRIAL SALES

119 CARLSON ROAD, ROCHESTER 3, N. Y.



labeled with units instead of introducing abstract designation of X, Z, and U. Also, the determination of the decimal point is not left to the discretion of the operator's skill.

I made repeated sample calculations with the nomograph published by Mr. C. Nachod and found that they could be done faster with an ordinary slide rule. Also, I was unable to find a solution for the values of N = 95 to 100 RPM or N = 950 to 1000 RPM on your nomograph. —Leo Fiderer
New York 5, N. Y.

Because of space limitations, intermediate points between 1 and 5, 5 and 10, etc. on Mr. Fiderer's nomograph have been removed.–**Ed.**

Back-To-Back Articles

To the Editor:

In the March issue eight of the articles are arranged in such a way that they cannot be removed for filing without taking along part of another article. Cannot you find some way to arrange these articles so each one can be removed by itself?

—Frederick C. Krummel
East Orange, N. J.

Ed–Your problem is one of long standing and is ever present. The best answer we have right now is to suggest that you write to our Reader Service Dept. for tearsheet copies of articles you wish to file where removing one article takes out the first or last page of another.

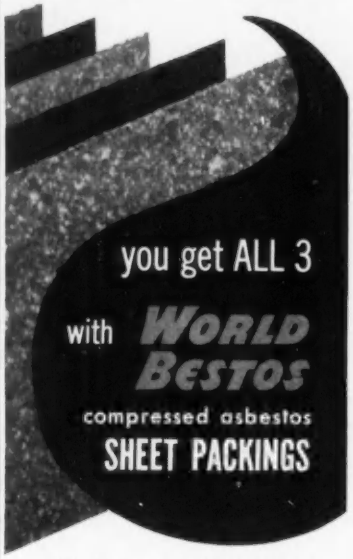
If you will make your request within two or three weeks after the issue reaches you, we will ordinarily

(Continued on page 429)

GASKET CUTTERS

—"supply" is no problem when you can count on

- PROVEN QUALITY
- ON-TIME DELIVERY
- COMPETITIVE PRICES



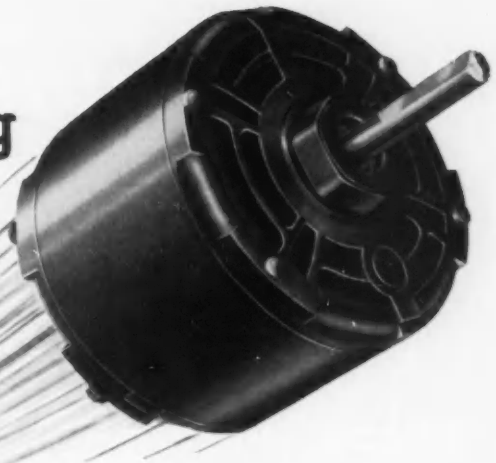
• World Bestos Packing Division of Firestone offers a dependable source of supply for finest quality sheet stock . . . using specially compounded binders of neoprene, GRS synthetic rubber and natural rubber.

World Bestos' modern equipment and ample plant capacity assure on-time delivery . . . at competitive prices. Firestone's extensive research and quality control facilities assure formulations and finished sheets of proven quality and uniformity. World Bestos is now supplying leading gasket cutters with sheets manufactured to S.A.E. and government specifications. Stocks are carried to meet emergency needs.

Write today for complete information on your requirements. Engineering assistance is available.

WORLD BESTOS
NEW CASTLE, INDIANA
PACKING DIVISION OF THE
Firestone
TIRE AND RUBBER CO.

there is something NEW in motors!



Sutco MINI-LAP*

PERMANENT SPLIT-CAPACITOR MOTOR

Built to Your Exact Specifications

Whatever your requirements in permanent split-capacitor or shaded-pole motors – Sutco can meet them.

Mini-Lap° Permanent Split-Capacitor Motors are built precisely to your specifications in ratings through 1/3 H. P. with highest efficiency and power factor.

Sutco Shaded-Pole Motors are specifically designed to fit YOUR requirements. Ratings are:

- **2-Pole – up to 1/60 H. P.**
- **4-Pole – up to 1/8 H. P.**
- **6-Pole – up to 1/4 H. P.**

Refer your needs in motors to our staff of competent sales and product engineers for most economical recommendations.

Now, Sutco presents an entirely new concept in permanent split-capacitor motor design – the MINI-LAP.° Minimum overlap of expensive copper windings... fully automated winding of the stator reduce motor costs to a minimum – and produce higher efficiency.

Positive mechanical spacing between main and auxiliary windings of the 6-pole Mini-Lap° provide added protection against electrical breakdown. Steel stator ring supports rugged die-cast aluminum end heads.

*Patent Pending

WRITE TO SUTCO; ORIGINAL EQUIPMENT DIVISION

Sutco ORIGINAL EQUIPMENT

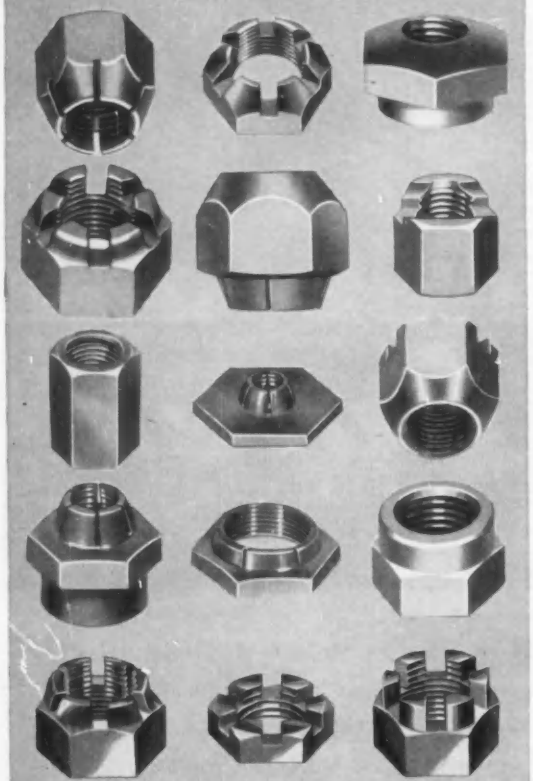
THE O. A. SUTTON CORPORATION, INC. • WICHITA, KANSAS

S-2

SPECIAL NUTS

to specs. 7/16" - 4-1/4" cross flats

special machines + large stock of material x years of experience = speedy deliveries high quality low prices



Here are a few samples made to customers specifications . . Our batteries of special high-speed multi-spindle, automatic machines make possible fast and accurate production of hexagon nuts of non-standard height and special shape from carbon or alloy steel, Naval bronze or other non-ferrous metals; also AN 310 through AN 335 as per latest Airforce specifications. Very often the special nut you require may be similar to one we are already making and a simple modification would result in a price advantage and quicker deliveries to you . . Send us your blueprint and particulars —let us quote on your requirements . . We also have a catalog that contains complete specifications, engineering data and prices regarding our standard nuts.

NATIONAL MACHINE PRODUCTS COMPANY

Manufacturer of Standard and Special 12 Point* *and Hexagon Nuts . . . "Huglock" and "Marsden" locknuts.*

44253 Utica Rd., UTICA, Michigan

Light metals design tips

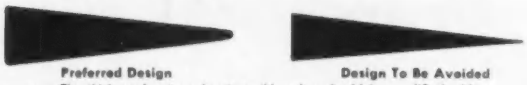
Easy extrudability makes magnesium ideal for many uses

Magnesium is easily extruded. This makes it ideal for many product applications where other metals would not be suitable. The use of re-entrant angles and undercuts, thin wall tubing of large diameter, variations in section thickness, and the ability to put metal where it is needed almost without restriction are a few design factors which make magnesium extrusions worthy of consideration for many structural purposes.

Here are some design tips which may help you decide if the metal and the process are suitable for your products.

Preferred Design — **Design To Be Avoided**

a Very thin sections with large circumscribing area should be avoided. The optimum width and thickness ratio for magnesium extrusions is normally less than 20. Higher ratios can be manufactured but require more generous tolerances.



Preferred Design — **Design To Be Avoided**

b The thick wedge tapering to a thin edge should be modified with a rounded end, as the metal will not fill the thin edge of the die properly during extrusion.

Preferred Design — **Design To Be Avoided**

c The thin leg attached to a thick body of an extrusion should be limited to a length not exceeding ten times the leg thickness.

As we use magnesium extrusions extensively in our own products and in parts and products we fabricate for others, we can give you authoritative, unbiased answers to specific questions you may have on this subject. More about this in other "design tips" in this series. Meanwhile, write for our Design Handbook.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

magcoa

SINKO BUILDS AGAIN!

60,000 SQUARE FEET OF SPACE IN A MOST MODERN PLANT DEVOTED ENTIRELY TO MOLDING OF PRECISION PLASTIC PARTS FOR INDUSTRY

This is the third time in the past 6 years that we have found it necessary to expand our facilities . . . due to the ever-increasing demand for Sinko Precision Plastic Moldings by more and more of the country's most critical buyers. Many of the nation's leading industrial concerns are today being supplied by Sinko with their needs in accurately produced Plastic Molded Parts and Products.

We mold all Thermoplastics including Nylon, and invite inquiries from you on your requirements in Molded Plastics!

Our Plastic Molding and Finishing facilities are most comprehensive . . . and we are excellently equipped to render you a complete service, including the following:

- Design and Engineering
- Injection Molding (4 to 100 oz.)
- Mold, Tool and Die Making
- Metal-Plastic Assemblies
- Vacuum Distillation Plating
- 2 and 3 Color Plastic Spraying
- Hot Stamping, Painting
- Fabricating and Assembling

Sinko

SINKO MFG. & TOOL CO.
7310 W. WILSON AVE. • CHICAGO 31, ILLINOIS

have a large enough supply to fill your needs. There is no charge for this service as long as the request is for a single copy.

Can Resolvers Accept Negative Values?

To the Editor:

I would be interested to know if the statement: "Mechanisms can also combine components to obtain resultant," made in the caption of Fig. 5, page 201, March issue of *Product Engineering*, is strictly true. An inspection of (C), Fig. 5, seems to indicate that if, say, X = 0 and Y tries to change from a positive to a negative value, the pin hits the end of the slot—a serious practical difficulty. It apparently can go no further until the "a input gear" is caused to turn through 180 deg.

Perhaps there is an additional mechanism which obviates this difficulty, not shown due to the simplified nature of the diagram?

—D. S. L. Durie
Toronto, Canada

Ed—You are quite right. The component resolver shown in Fig. 5C, page 201 of our March issue cannot accept negative values. As you suggested, when dealing with negative values 180 deg has to be added to the vector angle.

We've checked with the Ford Instrument Co., Long Island City, N. Y., and they state that they have a "vector solver" that can accept negative values.

Functional Design of Hydraulic Circuits

In a 16-page special report to appear in the July issue, authors H. L. Stewart and J. M. Moritz of Logansport Machine Co., discuss how application and purpose determine component choice and circuit configuration, how force and speed requirements are translated into pressure flow and power unit specifications. Specific suggestions for sequencing and synchronization are offered to meet specific functional needs; desired method control directs choice of control valves, circuit layout and safety interlocks.

FILTER FORUM

New publication by Purolator is the first comprehensive filtration guide ever edited specifically for designers

Question:

Where can a designer find all the answers to his filter problems?

Where can filters be used profitably? When should they be used? How do filters save money? What are the facts about degree of filtration, flow rate, contamination to be removed, viscosity of fluid? These are questions that continually come up in design work. But, up to now, no handy, authoritative source has been available for the designer's files.

Answer:

Purolator's new "Filtration Manual for Product Designers"

Now, for the first time, Purolator's new manual gathers all the answers in one place and makes them available to the product designer. "Filtration Manual for Product Designers" spells out application considerations in detail and includes a complete glossary of terms that apply to filtration. Here are some typical section headings:

	PAGE
WHY ARE FILTERS USED	4
WHERE FILTERS ARE USED	6
PLANNING FILTRATION IN ADVANCE	8
FILTRATION ENGINEERING	10
How filters are applied	10
Glossary of filtration terms	16
How Purolator filters are made	18
WHERE THE DESIGNER CAN SELECT A FILTER	22
Gasoline engine lubrication	23
Tank and crankcase breathers	23
Air intake for engines and compressors	23
Hydraulic fluid	24
Machine tool coolant	25
Bulk fuel handling	26
Diesel engine fuel	28
Diesel engine lubrication	28
Fuel oil burner	29
APPLICATIONS THAT CALL FOR SPECIALIZED STUDY	30

PUROLATOR
FIRST in the field of filtering

MAIL THIS COUPON FOR YOUR COPY

Dept. D-7-296, Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following:

_____ Copy of "Filtration Manual for Product Designers". I'm including 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME_____ TITLE_____

COMPANY_____ ADDRESS_____

CITY_____ ZONE_____ STATE_____

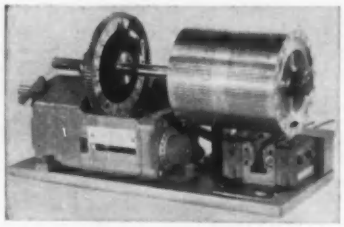
CIRCUIT CONTROLLING COUNTERS *with Automatic Reset*

FOR REVOLUTION, STROKE AND ELECTRIC COUNTING

THESE predetermining counters with instantaneous reset will automatically recycle a variety of single and multi-stage switch functions. Recycling operates without time lag at speeds to 5,000 rpm. The switching pattern repeats automatically as long as desired. The control circuit is an integral part of the equipment.

CYCLO-MONITORS

Used to control one or two switching events within a preset count-cycle. Replace unwieldy change gears, cam systems, timing chains, etc.—provide quick and completely flexible adjustment for changing requirements. Adjustment in one-count increments extends over a wide range of numbers. Available in a variety of models—*write for General Catalog of Cyclo-Monitors.*



PROGRAMONITORS

Same cycle range as Cyclo-Monitors, but also permit ANY NUMBER of intermediate switching events. Complex switching patterns of any countable sequence can be programmed and automatically repeated. Momentary or dwell switching—continuous or intermittent operation. Built-in control circuit can be opened or closed at any numbers. *Write for Bulletin 505.*

COUNTER AND CONTROL
CORPORATION

5221 W. Electric Ave.
MILWAUKEE 14, WIS.

PRESS PREVIEWS

Electronics in Management

How business management can improve its decisions with the aid of electronics is described in a series of four 35-mm color sound filmstrips just released by the American Management Association, national management educational organization.

The filmstrip series is the first training film on electronic data processing that covers the complete field—evolution, definition, machine function, methods and applications, effect on personnel policy and company planning, and future developments.

The series, entitled "Data and Decision: Using Electronic Computers in Business," deals with the development and business application of the electronic digital computer. It is intended for orientation of top management, financial executives, and clerical and nonclerical employees in the elements of electronic data processing.

Each of the four filmstrips in the series is designed as a self-contained unit. Together they constitute a complete, non-technical training program in electronic data processing, explaining how the computer evolved, how it works, how to plan it, and how to use it. Part I, "Data Processing and the Computer," is designed particularly for office personnel and shop supervisors, foremen, and workers. It explains the logical evolution of computers in terms of data-processing functions and standard business methods. A non-technical basic explanation of what the computer is and how it works is provided in Part II, "The Computer System." It is intended for office personnel and financial and middle management who will be involved directly or indirectly with the computer. For the general orientation of financial, middle management and top management, Part III, "The Feasibility Study," tells how to go about finding the right electronic data processing system for the job, what a feasibility study consists of, and at what point in the study a decision on computer installation may be made. Part

(Continued on page 433)

3 ANSWERS TO POWER PROBLEMS

More flexible shafts are being used in the electronic field today because they offer an economy in time, space, and costs.

There are three types of flexible shafts available, each having certain advantages of its own.

The FIRST type of flexible shaft is power drive, which transmits power between two points where, due to position, solid shafts cannot be used. The power drive flexible shaft provides for rotation either clockwise or counter-clockwise with the wire wound according to the direction rotation in order to strengthen the cable while the assembly is in use.

SECOND is the remote control flexible shaft which offers the advantage of rotation both clockwise and counter-clockwise and may function in either a continuous or an intermittent operation. The remote control flexible shaft has proven its value many times where the driven element required only a fraction of a turn or many complete turns and where both rotation and reciprocation were required.

The THIRD type of flexible shafting is the coupling which is an added application of the remote control flexible shaft and is most useful to control the movement of parts within a piece of equipment. There are no alignment problems to contend with because the flexibility of the coupling compensates for any difference in alignment between the drive and the driven elements.

For complete information and a better understanding of flexible shafting write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois.

HOMMEL CERAMIC AND CERMET PROTECTIVE COATING

PROTECTIVE COATING FOR METALS SUBJECT TO HIGH TEMPERATURE

- **RESEARCH**
- **DEVELOPMENT**
- **PRODUCTION**

THE
O. HOMMEL CO.
PITTSBURGH 30, PA.
"THE WORLD'S MOST COMPLETE CERAMIC SUPPLIER"

You can draw and form them LITTLE

or fabricate them BIG

with the new A-L low-nickel STAINLESS GRADES

WRITE FOR THE ASSISTANCE YOU NEED

1. "TECHNICAL STUDIES #3"

. . . essential information on the composition, properties, fabricating methods and applications of AL chromium-manganese, low-nickel stainless steels. *Write for your copy.*

2. TEST SAMPLES

. . . We'll be glad to supply engineering assistance, and actual samples of these 200-Series steels for testing under your processes and conditions.

ADDRESS DEPT. PE-78

In the top photograph, the fabrications you see are a mixing bowl, a tea-kettle base, a lock case and a patented shoe fastener: all made of A-L Type 201 or 202 chrome-manganese low-nickel stainless. The finish is good, the steel handled the same in the presses as Types 301 or 302, and similar drawing, buffing and polishing procedures were followed.

As in the lower illustration, the chrome-manganese low-nickel grades are being used also for fabrications as large as truck trailers and railroad coaches. Again, forming qualities and weldability present no problems, and results are entirely satisfactory.

Sum it all up and this is the answer: you *won't* encounter any particular differences in fabricating the 200-series of stainless steels . . . you *will* find some advantage in price, and a very important factor of much greater availability in times of nickel shortage. ● Why not take advantage of our pioneering experience with the low-nickel grades—let us help you use them. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

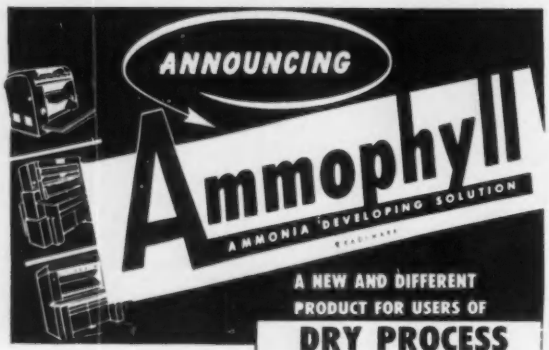
WSW 6060

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

AL STAINLESS STEEL

Warehouse stocks carried by all Ryerson Steel plants



WHAT IT IS:

AMMOPHYLL is a new, fully tested in the field, scientifically formulated developing solution that minimizes the disagreeable odor associated with ordinary ammonia. It was developed specifically for use in dry process whiteprinting equipment.

WHAT IT DOES:

This "quality controlled" developing solution consistently develops better prints than ordinary ammonia. You get such results as sharper lines, clearer lettering, and better contrast.

WHAT IT MEANS TO YOU:

1 — Safety . . . the ammonia odor is effectively masked. AMMOPHYLL is shipped in one gallon and two gallon polyethylene bottles and in the new 13 gallon and 55 gallon, steel drums which have an inner liner made of polyethylene which is one of the safest shipping and storing methods.

2 — Performance . . . AMMOPHYLL is tailored for the consumer. You get the same strength solution and high quality every time. It never varies. It's your guarantee for trouble-free development.

3 — No mixing . . . AMMOPHYLL comes ready mixed. This is done scientifically in our plant by blending chlorophyll and other additives. Distilled water is used. This is to assure water that is free from foreign matter that might damage valuable equipment.

SPECIAL FACTS:

AMMOPHYLL is available in three strengths—

Solution No. 1 where full strength ammonia is required

Solution No. 2 where less than full strength ammonia is required

Solution No. 3 for use in desk and office model machines requiring lower strength ammonia.

STEEL DRUM AND POLYETHYLENE LINER

AMMOPHYLL is guaranteed not to damage machines in normal use. It has been tested and approved by leading whiteprinting equipment manufacturers.

We have distributors and dealers throughout the United States, Mexico, and Canada.

• Write for free brochure and details. •

RESLABS, INC. Division of Linco Products Corp. Dept. D
2155 WEST 80th STREET
CHICAGO 20, ILLINOIS

NEW . . . NEW!

Gear-Grip
Flexible Coupling

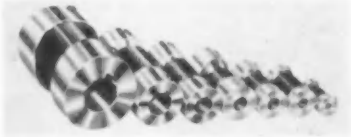
The most revolutionary design advancement for integral H.P. in a century!

Positive power transmission of rated load. Gear teeth on end castings match special rubber tube section.

- Load ranges—2½ H.P. to 25 H.P.
- Shaft sizes—¾" to 1⅞".
- Specified lengths to design requirements.
- Prevents end thrust.
- "By Eye" shaft alignment.
- No lubrication required.
- Shaft Safety features.

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



5R 4R 3R 2R 1R 0R 00R

- True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.
- Lengths varied to design specifications in each series.
- Load ranges—1/15 to 1½ H.P.
- Shaft sizes — 3/16" to ¼".
- Lowest O.D. for highest torque capacity.

Write for Catalogs and Technical Bulletins.

Guardian
QUALITY IS TRUE ECONOMY

Guardian PRODUCTS CORP.
COUPLING DIVISION

DEPT. P-66, 1215 E. SECOND ST. MICHIGAN CITY, INDIANA

IV, "The Electronic Frontier in Business," emphasizes applications, both current and long-range. It presents electronic systems at work on such pay-out applications as payroll, material, and inventory control and illustrates the frontier uses that represent the significant long-range contributions of the computer, for example, operations research.

Companies and other interested groups may obtain prints of the four filmstrips accompanied by sound recordings and a manual containing scripts and other material for conducting training programs from the Visual Education Department, American Management Association, 1515 Broadway, Times Square, New York, 36, N. Y.

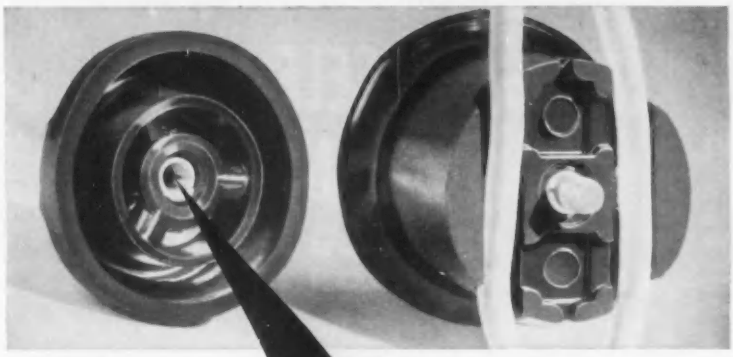
Yale Introduces New Fork Truck Line

The completion of a $5,000,000, three year research and manufacturing program has produced a new line of Yale fork trucks, including gasoline, LP-Gas, diesel and electric powered models. Many engineering features currently popularized by the automotive industry have been included in standard models of the new vehicles. Highlights among these features are fully automatic torque converter transmission, self-adjusting brakes, power steering, and high travel and lifting speeds.

All Yale gas trucks can be obtained with a new, fully automatic hydraulic torque transmission. This transmission permits precise "inching" under either full load or no load conditions, and provides the power necessary for time saving, simultaneous operation of lifting and tilting, and fully normal use of attachments.

Integrated in the new lines are other features which have been extensively field tested. Among these are self-adjusting hydraulic brakes which automatically maintain proper clearance between lining and drum. Brakes of greatly increased capacity are mounted directly on the wheels as different from braking systems in which the brakes are applied at a distance from the wheels through a series of mechanical elements. In addition to the hydraulic brakes, all Yale electric trucks have a "deadman

(Continued on page 434)



PIP* push inserts make perfect threads

WITHOUT TAPPED HOLES OR SOLID BUSHINGS

Threads without tapping at less than 1¢ per hole installed. Just push-in-place a PIP Push Insert and you have perfect female threads in cast, molded or drilled blind or through holes. Spring-like PIP Inserts lock securely in place in plastic, aluminum, zinc and all other molding and die-casting materials.

The illustration shows a typical application. The PIP Insert in the cap of this common electrical socket provides threads strong enough to impale the two covered wires on contact prongs. The insert was pushed into a plain cored hole after molding, avoiding long cycle time required by molded-in solid bushings.

PIP Push Inserts are perfect for production line application. Either a drill press, kick press, arbor press or air piston —and a few dollars in tooling—are all you need to install perfect threads in 1,200 holes per hour.

Write today for samples and full information.

*Product of Heli-Coil Corp. –Pat. Pending

HELI-COIL CORPORATION
166 SHELTER ROCK LANE, DANBURY, CONN.

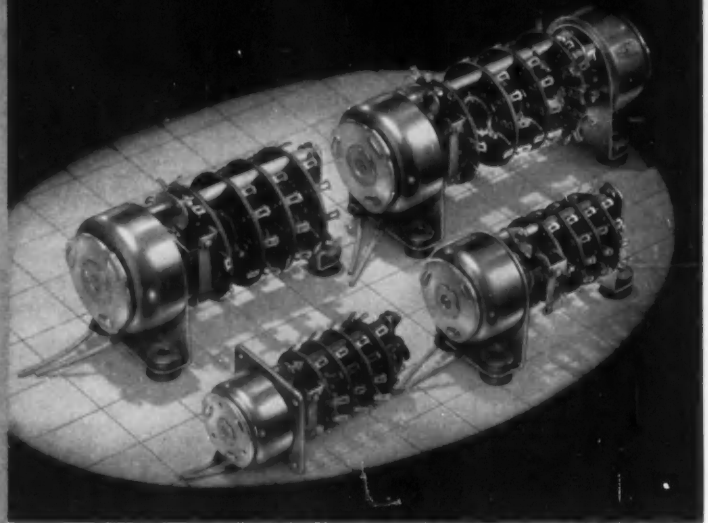
☐ Send Standard PIP Push Insert Application Chart and other information on this new technique.
☐ Send design data on *Heli-Coil* Screw Thread Inserts.
☐ Send design data on *Heli-Coil* Screw Lock Inserts.

NAME_____ TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____ 3054

Heli-Coil Corporation: Manufacturer of *Heli-Coil* Screw Thread Inserts, *Heli-Coil* Screw Lock Inserts and *Heli-Coil* PIP Push Inserts.

LEDEX SELECTING and STEPPING RELAYS

WILL HELP YOU SIMPLIFY REMOTE SELECTION of CIRCUITS!



A few examples of standard Model, Ledex relays. Use the 1" squares in the background to estimate size of the relays.

Ledex Relays are available to perform a variety of switching jobs... STEPPING...COUNTING...ADDING AND/OR SUBTRACTING...PROGRAMING... CIRCUIT SELECTING...and HOMING.

SEND US, ON YOUR LETTERHEAD, THE DETAILS OF YOUR SWITCHING REQUIREMENTS AND LET LEDEX ENGINEERS WORK WITH YOU TO DETERMINE IF LEDEX RELAYS ARE THE ANSWER.

G. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO

IN CANADA, MARSLAND ENGINEERING LTD., KITCHENER, ONTARIO

control" built into the seat which automatically sets mechanical wheel brakes when the operator leaves the truck.

Other safety features included in the new designs are the use of an anticavitation unloading valve and a flow regulator valve in all trucks. The unloading valve is mounted in the hydraulic tilt system to prevent the possible formation of a void which would cause channel sway and loss of positive channel control. The flow regulator always assures smooth lowering control without excessive speed regardless of size of load.

GPL Breaks Ground for New Test Lab

General Precision Laboratory, Inc. this week broke ground for a new Environmental Test Laboratory. The building, situated on the company's sixty-nine acre property at Pleasantville, N. Y., will contain 23,200 square feet of floor space and will substantially increase GPL's present facilities for the environmental testing of military electronic equipment. It will house additional test apparatus to simulate wide variations of temperature, altitude, humidity, acceleration, and vibration and shock effects. The equipment is capable of duplicating a wide variety of climates and weather conditions.

Systems or individual components can be subjected in the Laboratory to any altitude pressure from sea level to 100,000 feet, temperatures ranging from −80 C to 300 C, acceleration forces from standstill to 50 G's, 65 G's of shock, relative humidities from twenty to ninety-five per cent, and vibration frequencies under varying temperature extremes from 2 to 2000 cycles per second with simultaneous acceleration up to 38 G's. Sand and dust storms of variable densities with air velocities to 250 feet per minute can also be reproduced at controlled ambient temperatures from 20 C to 80 C.

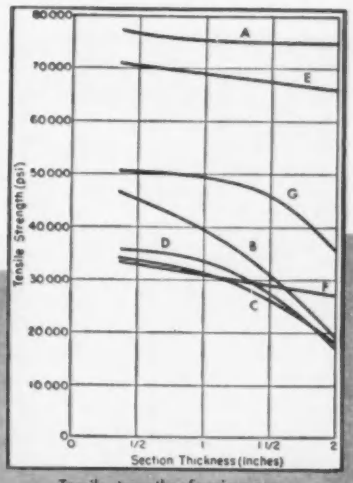
For marine environments, salt fog can be created with relative humidity content of 95 to 100 per cent at temperatures of 65 F to 125 F. Tropical conditions can be duplicated in fungus cabinets having up to 90 F temperature. Equipment is also exposed to

(Continued on page 437)

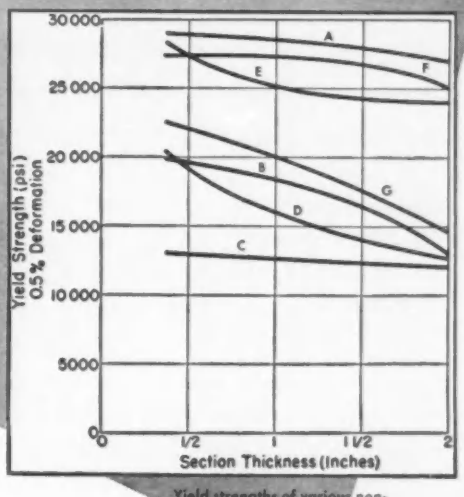
Here's proof....

that you can use lighter sections, have greater strength, improve your product, save money

with AMPCO* Metal



Tensile strengths of various non-ferrous metals vs. section thickness



Yield strengths of various non-ferrous metals vs. section thickness

Examine these charts carefully — they tell a story that can save you money and put extra life and dependability into your product.

Look, for instance, how other non-ferrous metals show a sharp decrease in mechanical values as casting cross-sections increase. Ampco remains practically constant — you require less metal.

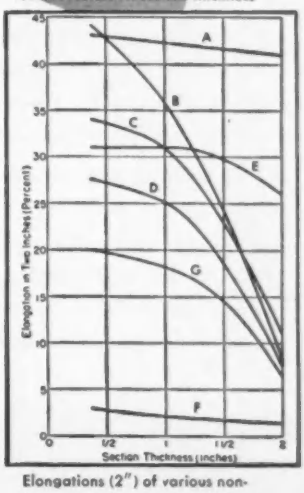
Note Ampco's unusually high tensile and yield strengths compared with conventional bronzes — you use lighter sections to do a better job. And Ampco Metal weighs 10 to 15 percent less than other bronzes — so you can make important weight reductions.

Fact is, Ampco Metal's high strength-to-weight ratios can mean real savings for you — savings in material and money. Consult your nearby Ampco field engineer for full information or write us.

CHART REFERENCE

- A. Ampco Metal
- B. Tin Bronze (88-8-4)
- C. Red Brass
- D. Tin Bronze (85-5-5-5)
- E. Manganese Bronze
- F. Aluminum Alloy
- G. Silicon Bronze

Charts courtesy Materials & Methods and Westinghouse Electric Corp



Elongations (2") of various non-ferrous metals vs. section thickness

AMPCO®

Sole Producer of Genuine Ampco Metal

AMPCO METAL, INC.

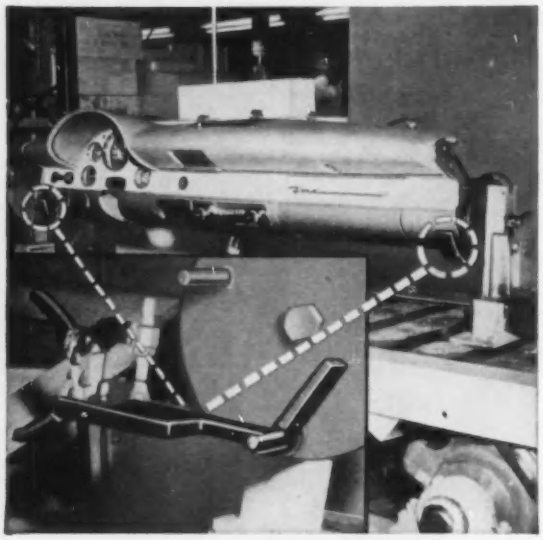
Dept PE-6 Milwaukee 46, Wisconsin

West Coast Plant: BURBANK, CALIFORNIA

*Reg U S Pat Off

D-43

another product improved . . .



chem·o·sol®

cushions this production line

Tough, resilient **chem-o-sol** cushions the supporting arms, bans scratching as automobile instrument panels travel this production line. "In-plant maintenance costs have been reduced" is the theme of our customer's field report.

Chem-o-sol coating in this case was applied in the plant by a very simple dipping process. Had the parts been too bulky to dip, spray **chem-o-sol** would have been equally satisfactory for in-plant application.

We custom formulate **chem-o-sol** — a 100% solids liquid vinyl dispersion — for each application. To answer specific needs we have developed **chem-o-sols** for application by dipping, molding, spraying, die-wiping, spreader coating, printing and other methods.

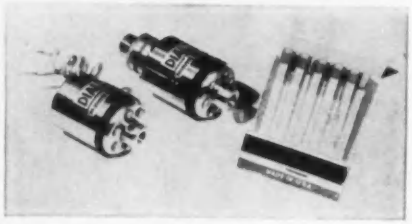
Our plant is the largest in the world devoted exclusively to plastisol research and production. In this field we have pioneered countless new developments. Write for Bulletin 141, telling all about **chem-o-sol** — and describe your product problems. We can formulate the *exact* **chem-o-sol** for your needs.

Chemical Products CP CORPORATION

KING PHILIP ROAD • EAST PROVIDENCE, R. I.

MAGNETIC CLUTCHES & BRAKES

Miniature in size, they are giants in performance.



A line of seven standard types, each in two sizes, now gives the design engineer an opportunity to utilize a miniature clutch at the utmost economy in applications where a simple disconnect or non-chattering brake is required. Special models are also available for continuous slip or for accurate tension or torque control.

The units range upward from one weighing only 2½ ounces with less than 1" OD which delivers 30 inch-ounces of torque on about 2 watts of power.

FOR INFORMATION ON THE FULL LINE SEND FOR OUR NEW CATALOG NO. 955. It contains complete specifications and performance charts.

DIAL PRODUCTS COMPANY

9 Avenue E (HEmlock 7-0720) Bayonne, N. J.

WHEELS WHEELS WHEELS

for Products That Roll!

Be SURE With —

ALLIED Rubber Tired, Metal Disc Wheels; All Sizes & Kinds!

CONSULT ALLIED ON ALL YOUR SMALL WHEEL NEEDS!

• Build quality—lasting service—sales appeal — customer satisfaction into your product with ALLIED Wheels! Big range of stock sizes and types — or produced to your precise specifications. Priced "right"; with dependable delivery to meet your production schedules

ALLIED Wheels....
PRECISION MADE TO YOUR SPECIFICATIONS!

WRITE TODAY!

ALLIED WHEEL PRODUCTS, INC.

27 BROADWAY • TOLEDO 4, OHIO

Representatives And Warehouses In Principal Cities

combustible gas mixtures in an explosion-proof chamber which simulates altitude pressures up to 70,000 feet. Shielded rooms provide for radio interference and susceptibility testing.

Also located in the new structure will be offices for the use of the test laboratory technicians. Present plans call for completion of the building in late 1956.

National Aniline To Build Research Addition

The National Aniline Division, Allied Chemical & Dye Corporation, has announced plans for erection of an addition to its Research-Engineering Center at the Buffalo, New York, plant. This new building will provide increased space for application research on diisocyanates being produced by National Aniline Division under the trade-name of "Nacconates". Currently work is continuing for such uses as flexible and rigid polyurethan foams, rubber, protective coatings, adhesives, textile, paper and leather treatment.

The new company plant for producing the "Nacconates" is nearing completion in Moundsville, West Virginia. This will provide large-scale facilities for production of the diisocyanates. The need for increased capacity for application research has come within a year of the dedication of the new large Research-Engineering Center, and graphically illustrates the growth and expansion of research on new products by the National Aniline Division. The new addition will be a one story structure providing approximately 10,000 sq ft of floor space. It is expected to be completed for occupancy late this year.

Toastmaster Launches Diversification Program

Toastmaster is inaugurating a program of product diversification this year in celebration of the 30th anniversary of the firm's development of the first automatic pop-up toaster.

Known essentially as a toaster manufacturer throughout its 30-year history, the firm announced that it will branch out to a number of new automatic electrical products during 1956. Al-

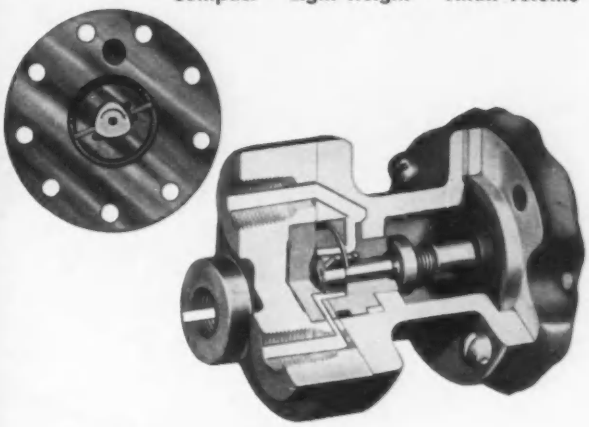
(Continued on page 438)

WELDON

FLUID METERING PUMPS

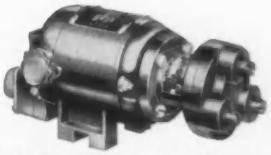
Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.

Compact • Light Weight • Small Volume

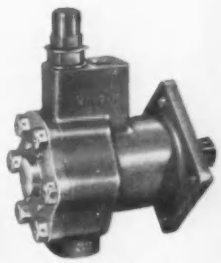


IT'S SO SIMPLE!

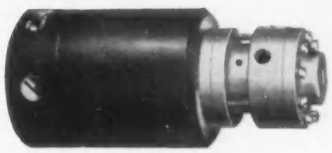
The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



STYLE A—Single inlet double outlet type aircraft pump



STYLE F—Engine driven fuel pump

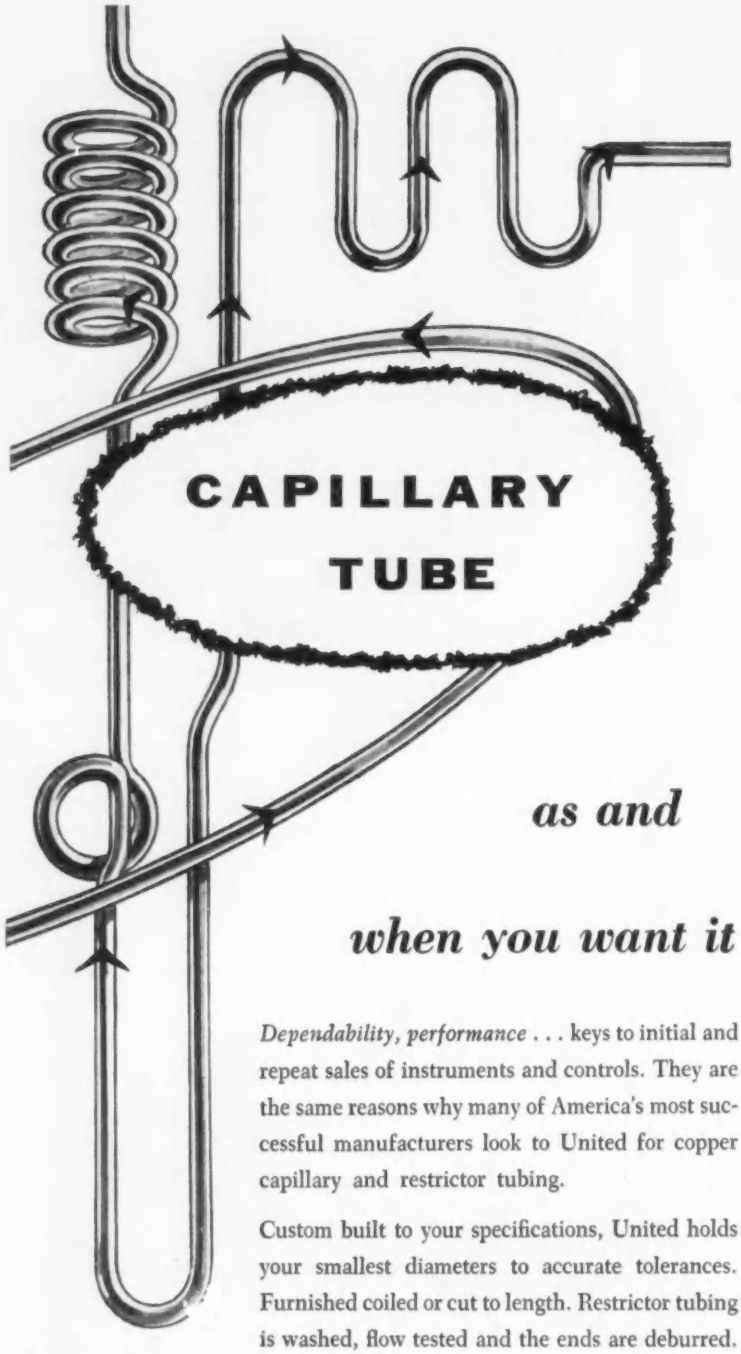


STYLE C—Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO



as and

when you want it

Dependability, performance . . . keys to initial and repeat sales of instruments and controls. They are the same reasons why many of America's most successful manufacturers look to United for copper capillary and restrictor tubing.

Custom built to your specifications, United holds your smallest diameters to accurate tolerances. Furnished coiled or cut to length. Restrictor tubing is washed, flow tested and the ends are deburred.

FOR QUALITY, ALWAYS SPECIFY UNITED

Permanently United

UNITED WIRE

AND SUPPLY CORP.

PROVIDENCE 7, R. I. • OFFICES IN PRINCIPAL CITIES

LOOK TO UNITED FOR THE BEST IN ALUMINUM, COPPER AND BRASS TUBE AND WIRE.

ready it has introduced five new automatic household appliances. At the end of 1955, the firm brought out an automatic waffle baker and an automatic iron. Just introduced are three more products; an automatic fry pan, a grill and waffle baker combination, and a new idea in home appliances, a Hot Food-tainer. Others are in various stages of development.

The key to Toastmaster's success throughout its history, has been the performance of its thermostatic controls, basic to all automatic appliances involving heat. The know-how Toastmaster has gained in its years of developing and improving such controls will be utilized in the manufacture of the new products.

In 1925, Murray Ireland, then the factory superintendent and now President of Toastmaster Division of McGraw Electric Co., designed the first automatic pop-up toaster for home use. It was based on a heavy duty toaster invented earlier by Charles Strite and made by McGraw Electric Company exclusively for restaurant use.

The household model of this first automatic pop-up toaster—a one-slice unit—was offered to the public in 1926 at $13.50. At first wholesalers and retailers had misgivings about it because the average price of toasters at that time was $5.95. They were, however, neither automatic nor pop-up. At that time, Toastmaster employed women as traveling salespersons. When the women were refused orders, they would request an opportunity to demonstrate the product in a store. And the public liked it.

In addition to bringing out the first automatic pop-up toaster, Toastmaster also presented the first oven-type toaster which toasted on both sides at once. At the same time it brought out the oven-type toaster, Toastmaster also introduced the first controls allowing the user to regulate the toaster to make either lighter or darker toast. The firm's next step was the introduction in 1932 of a flexible timer which eliminated the need for preheating the toaster by automatically adjusting the speed of the clock-like timing device to the temperature of the toaster.

In 1942, a new type of toast timer was developed. This timer eliminates one of the basic problems in proper operation of electric appliances—the variations in voltage. Voltage can vary

(Continued on page 440)

Remote or automatic switching

AT HALF THE COST

with Westinghouse motor-operated AB circuit breakers

Now you can use a pushbutton or relay to electrically operate a Westinghouse AB circuit breaker. You can add load switching to your circuit protection — from a convenient point or under pre-determined conditions. And all without the need for a costly breaker-contactor combination or an expensive, large air circuit breaker.

Cost of the motor operator is but a small fraction of that for a large contactor. In fact, the complete dual-purpose breaker (breaker and motor operator) cost less than a contactor alone. Don't forget either the valuable space you save by eliminating contactors or by replacing larger breakers.

With the Westinghouse motor-operated circuit breaker you get all the proved AB De-ion® protection features. In addition you have your choice of such internal aids as reverse-current trips, undervoltage trips, and auxiliary or alarm switches. The motor operator can be applied to breaker Types J, K, KL, L and M in ratings of 70 through 800 amperes.

If it's remote or automatic breaker switching you need, consider the real savings possible with motor-operated AB circuit breakers. Your local Westinghouse sales office will be glad to help — or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-30213

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

3 Morganite uses to crow about...

1st Use:
During 4½ years—and 19,000 steaming hours—in a chain grate stoker, *Morganite bearings required no lubrication and no maintenance.* Bearing wear was only 0.030" and the shafts were highly polished with negligible wear.

2nd Use:
Several hundred Morganite bearings, fitted to a 150 ft., double-roller, suspension conveyor, passed continuously through (1) caustic solution at 190° F, (2) water at 180° F, (3) Bonderite Solution at 190° F, (4) Chromate rinse at 180° F, and (5) a drying oven at 450° F. *After more than 17 years these bearings are still giving satisfactory performance.*

3rd Use:
In a 10-ton furnace charging machine, Morganite bearings have been operating in the "hot zone" for more than 3 years *without replacement or maintenance.*

If you have a problem involving severe temperatures, lubrication, or contamination, send us the details. Our Engineering Staff will be glad to work with you.

50th ANNIVERSARY 1906 · 1956

Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3306 48th Avenue, Long Island City 1, New York

considerably in different outlets in the same home. It also varies considerably in the same outlet at different times of the day. The present timer compensates for such variations, making a perfect toasting process possible no matter what the voltage fluctuation may be.

Toastmaster is now producing seven different models of toasters. Three different models of the two-slice are available in chrome, two automatic and one Powermatic. Just introduced are a new two-slice copper model and a deluxe, 24-carat, gold plated model. For larger households, Toastmaster offers a Powermatic three-slice toaster

New UCC Silicones Plant In Operation

Several units of the new Long Reach, W. Va., plant of the Silicones Division, Union Carbide and Carbon Corporation, are now in operation. Built on a 1431 acre site to help meet the expanding demand for silicones, the plant is on the Ohio River, between Parkersburg and Wheeling. There are now 171 persons employed at Long Reach, with employment expected to rise eventually to about 360.

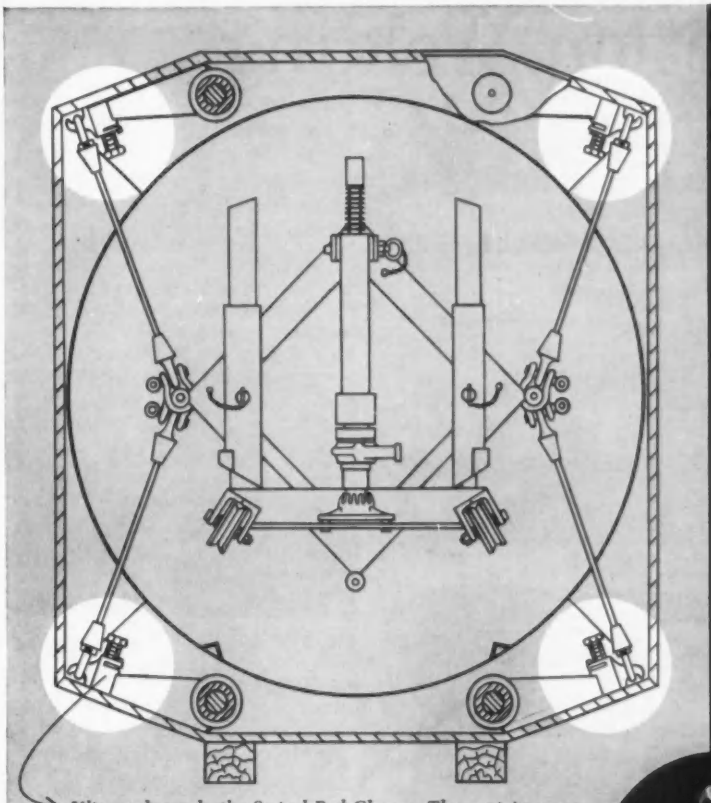
The original silicones plant at Tonawanda, N. Y., will continue in operation. Research and product development activities also have their headquarters at Tonawanda. Increasing amounts of the various forms of silicones—oils, insulating resins, water repellants and rubbers—are being used in the production of such diverse products as cosmetics, polishes, lubricants and masonry paints.

G. E. Opens New Motor Plant

What is believed to be the world's most modern factory for manufacture of induction motors was unveiled in Schenectady, N. Y., recently by General Electric's Medium Induction Motor Department. The new facility was built at a cost of approximately $7 million, and was designed to meet a rapidly expanding motor market which is expected to increase at least 75 per cent, industrywide, by 1965.

Actually three plants under one

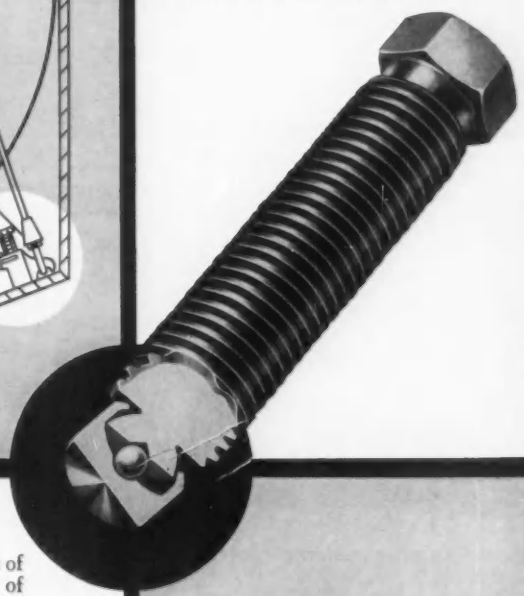
(Continued on page 443)



Vlier makes only the Swivel-Pad Clamps. The container is a product of American Pipe and Steel Corporation, Alhambra, California.

Vlier Ball-joint clamps

solve clamping problem for missile container manufacturer



The remarkable ball-joint design now used in thousands of Vlier Swivel-Pad Clamps can be adapted to a variety of clamping and holding applications. The drawing above of a missile shipping container demonstrates one adaptation which solves a particularly difficult problem. Eight special Vlier Swivel-Pad Clamps are used to release tension on cables which suspend the missile in its shipping container. Radar manufacturers are also using special Swivel-Pad Clamps to prevent damage to sensitive instruments during shipment.

PROTECTS SURFACE OF THE PART

The main advantage of the Vlier Swivel-Pad Clamp is that it exerts extreme holding pressure without damaging the surface of the object held. First touch of the pad against the object adjusts the pad face angle and stops pad rotation. The pad can then be tightened to hold the object securely, since the screw torque is absorbed by the pad, not the object.

Perhaps this unique Vlier ball-joint principle can be applied to your clamping problems. Vlier engineers will welcome your inquiries.

Insist on Vlier Tooling Accessories . . .
there's still no substitute for quality.

BALL-JOINT CONSTRUCTION—Eliminates binding, assuring proper adjustment of the pad against an off-angle surface. The pad swivels 7½° in all directions each side of the center line.

SPECIAL PAD AND SCREW DIAMETERS AVAILABLE—Normally pads are machined from solid stock and are not relieved or counterbored. However, other shapes, sizes, etc., can be designed to meet specific needs.

EXCELLENT STRENGTH—Screws are made from heat-treated alloy steel. Ball-joints have been designed to withstand as much as 21,000 load pounds (1" screw diameter).

VARIETY OF FINISHES POSSIBLE—Standard Swivel-Pad Clamps are Du-lited: however, cadmium, iridite, and other finishes to meet government specifications can be provided.

VLIER ENGINEERING INCORPORATED

8900 Santa Monica Boulevard
Los Angeles 46, California

Projection Welding

How to Use It to Improve Product Design and Quality

What is Projection Welding?

Projection welding is a resistance welding process for joining flat or shaped pieces of metal. The two work pieces generally are clamped under electrodes of considerable area that are either flat or made to fit the work. Formed projections or embossments are processed on one of the pieces before welding. Pressure is applied and the current divides equally among the projections and produces welds of approximate equal strength. The heating and pressure process continues until the projections or embossments are flattened sufficiently to bring the work pieces against each other.

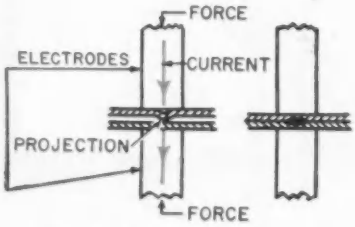


Fig. 1 Projection welding process.

Advantages of Projection Welding

A projection resistance weld requires no additional metal, arcs, gas or flame. *The weld is within the materials themselves*—and is as strong, if not stronger than the parent metals. It offers a 100% strength factor compared to 80% for arc or flame welds.

The simplicity of a resistance welding operation often reduces multi-step fastening operations and enables unskilled operators to produce consistent, high quality welds at peak production.

Many products that were not originally designed for resistance welding can easily be adapted with simple tooling. Costly jigs and fixtures can be eliminated too, because Sciaky resistance welding techniques practically eliminate warpage and distortion of work pieces.

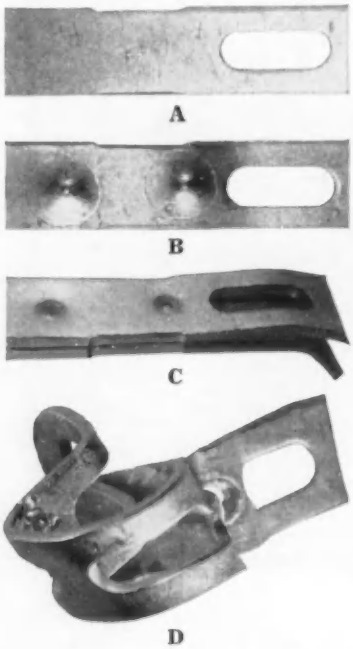


Fig. 2 A. & B. Phosphor bronze clips. Each is .020" thick and has been first silver, then gold plated. C. The welded part. D. The destruction test. Note the high strength bond and complete nugget separation from parent metal.

When to Design for Projection Welding

As a rule, this application is done in multiple projections simultaneously and also, this technique is very useful where several welds are to be made in a small area. It is often used to attach brackets or fasteners, or to join metal parts having machined projections. Metals of light thickness may be welded to heavy thicknesses. However, various metals do present problems, but with properly applied Sciaky techniques, metals such as aluminum and bronze are readily and effectively projection welded. Note Fig. 2—A, B, C and D.

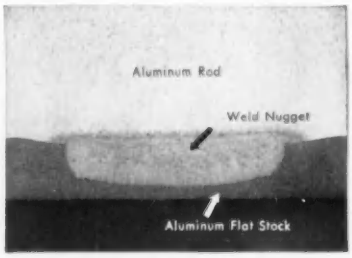


Fig. 3 Macrograph of all aluminum projection weld joining a rod to .062" flat stock.

Sciaky Research Center

Sciaky's new Research Center invites *you* to submit your fastening design problems. This entire facility, with the latest resistance welding machines, testing instruments, and trained personnel is devoted to solving your joining problems and advancing the application and development of resistance welding.

Write Today for Free Sciaky Literature

Start to build your data file on resistance welding today. Our "Resistance Welding at Work" publication, Vol. 3, No. 2 and Vol. 4, No. 1, contains case histories of Sciaky projection welding techniques. Designers' Guide Bulletin 331 discusses projection welding and other forms of resistance welding.

Describe your particular fastening problem on company letterhead and we will send suitable back and future issues of our "RWAW" publication. All contain impressive examples of Sciaky's basic thinking—resistance welding techniques designed to do *more useful work* at *lower operating costs* with *maximum reliability*.

Largest Manufacturers of Resistance Welding Machines in the World

SCIAKY

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

roof, the new motor plant has made possible a three 8-hour shift production cycle on standard models of the 7½ to 30 horsepower motors in the Tri-Clad 55 line. Formerly it took two weeks to produce these motors. The new plant makes extensive use of push button controls to machine, assemble, and test G. E.'s line of medium induction motors. These new operating controls have reduced to two the number of major hand operations involved in the manufacture of standard motors. Mr. O. F. Vea, general manager of the Department, said that "Despite this reduction in major hand operations, we are now employing more personnel than ever before".

Standard models are manufactured in a straight-line flow on left and right assembly lines, with special motors produced in a middle line which draws standard components from the other two. An example of this mechanized production line is an array of automatically operated punch presses stationed at the beginning of each production line for standard motors. Punching operations are fully automatic, including the feed of sheet steel into the presses, punching, conveying of the punchings from one press to another by means of magnetized belts, and the automatic removal of metal scrap.

All machining operations on 250-size frames are performed at a single machine where the feet are milled, footholes and conduit box holes drilled, shaft hole bored and rough-finished, and holes bored and tapped for the endshield bolts—all in a progressive series of automatically controlled operations. Each was previously a separate operation performed at four different machines.

In another fully automatic operation, wound stators are passed through three ovens in a dip-and-bake processing on a pre-set cycle of about six hours. They are progressively preheated, dipped into varnish, baked, given paint dip, baked again and finally given silicone dip. Hand operations are limited to loading and unloading.

The many testing operations demonstrate the great emphasis placed on quality control. All motors are tested automatically on a circular platform at the end of each standard line. De-

(Continued on page 445)

NOW!

control that vital operation . . . automatically!

Speed up production

Cut down on waste

Save valuable time

Automation can give you the jump on competition . . . and selection of the "right" industrial time controls can make a big difference in increased efficiency and reduced manufacturing costs. The AEMCO units listed below are just a few of the standard models which today occupy an important place in the nation's industry. Should you have a particular design problem which would not permit the application of a standard unit, write to our Engineering Department for information and quotations on your specialized problems.

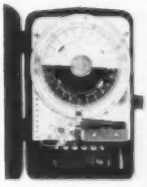
AEMCO

Manual, Automatic Re-set, or Continuous Cycling

INDUSTRIAL TIME CONTROLS

More "on" and "off" operations per cycle!

CYCLE MASTER TIME SWITCH



Not just a time switch, the "Cycle Master" may be used as a timer as well. Up to 48 separate "on" and "off" operations per cycle—available in 1, 12, or 24 hour cycling models. Time intervals between "on" and "off" operations of 37½ seconds on the 1 hour units adjustable up to 15 minutes on the 24 hour units by inserting pins. With or without skip-a-day feature in 10 and 20 amp. capacities. Also available with slide trippers; however, number of "on" and "off" operations per cycle will be reduced accordingly.

MARA AUTOMATIC RE-SET TIMERS

Actually two inter-connected adjustable timers, the MARA Series units permit varying not only the "on" and "off" periods, but also the length of the complete cycle. Units may be varied, for example to "on" 6 hours—"off" for 2 hours. This series may be supplied to operate in cycles from 10 seconds to 108 hours. Should either open or closed circuits require a short interval, one timer is provided with an extremely short time cycle for precise accuracy. Steel case measures 8"x 5"x4½"—equipped with a lockable metal hasp.

AR & MAR AUTOMATIC RE-SET TIMERS

Neat, compact, easy-to-set. MAR series available in cycles from 30 seconds up to 1 hour. The AR unit is available in cycles from 1 hour up to 96 hours. 10 amp. capacity — all models feature rapid re-cycle.

WRITE TODAY

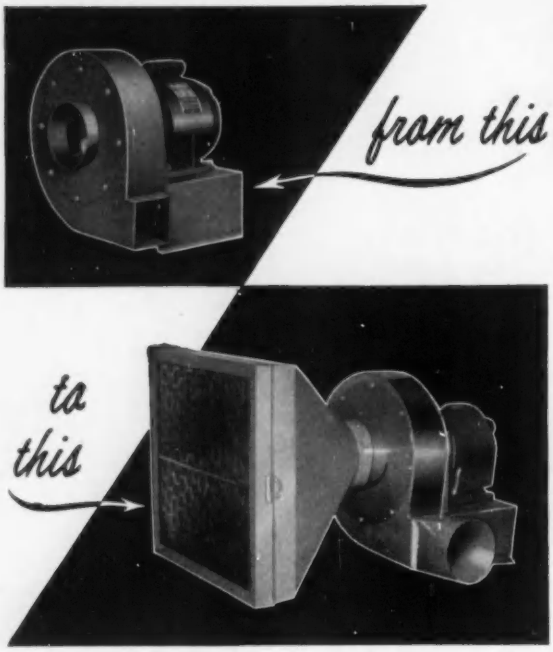
If you have a particular design or control problem we will be happy to help you solve it with a standard or custom AEMCO timer. For complete information write to:

AEMCO

AUTOMATIC ELECTRIC MANUFACTURING CO.

85 STATE STREET • MANKATO, MINNESOTA

TIME SWITCHES • INTERVAL TIMERS • SIGN FLASHERS • RELAYS • CONTACTORS



. . . And Peerless® Solves Another Electronic Gear Cooling Problem!

• This large aircraft manufacturer needed blowers to cool and ventilate stationary and airborne electronic gear. Peerless PW-12 Pressure Blowers were selected. Square-to-round discharge adapters with intake filters were fabricated to provide dust-free air. We are working continuously with many of the nation's top producers and users of electronic equipment. They know we design and build our own fans and blowers . . . motors and all. That's why we can unconditionally guarantee their dependable performance. From start to finish we have complete control of our product. Our engineers can work to your specifications to produce the fans and blowers that enable your equipment to operate at its best.

Write, wire or phone us now!
Ask for Bulletin SDA-160.

FAN AND BLOWER DIVISION
THE Peerless-Electric® COMPANY
FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
1406 W. MARKET ST. • WARREN, OHIO

63 JOBS YOU CAN DO BETTER with Cerro Alloys

The unusual properties of Cerro non-shrinking, low-temperature-melting alloys are especially valuable in four groups of industrial applications:

1. **DESIGN—in anchoring non-moving parts in machinery, and similar tasks.**
2. **PATTERN and MODEL reproduction.**
3. **PUNCH and DIE PART anchorage.**
4. **HOLDING work pieces of thin or irregular section.**

Cerro de Pasco has prepared a new folder listing 63 important industrial jobs in these groups, that can be done better with Cerro Alloys. This folder tells how you can obtain detailed information on any or all of these useful and cost-saving applications.

Send today for our new free folder:

"63 Jobs You Can Do Better with Cerro Alloys"

CERRO DE PASCO CORPORATION
52 East 50th St., New York 22, N. Y.

FOR POSITIVE, LOW-COST SPROCKET DRIVES . . .

TRY GENUINE BEAD® CHAIN

Now successfully employed in radio and TV tuners, recorders, air conditioners, timing devices, etc. Designed for economical, positive gear trains or drives free of slippage and backlash.

VERSATILE BEAD CHAIN
has many other advantageous applications such as:

- part retainers
- remote control devices
- fan or ventilator pulls
- revolving displays

and many others

WRITE TODAY FOR CATALOG AND SPECIFICATION SHEETS

THE BEAD CHAIN MFG. CO.
92 Mountain Grove St., Bridgeport, Conn.

signed to handle six motors at a time, the platform is rotated to perform tests on a total three-minute cycle for such factors as vibration, noise, electrical resistance, high voltage reaction.

As they leave the final test platform the motors are crated and raised by an automatic lift into a giant, slotted storage bank—similar in principle to the self-filling slots in some food markets. Accommodating more than 1,000 boxed motors at one time, the bank receives the motors at one end—placed into slots according to size and model—and by means of sloped roller conveyors allows each box to move forward as the boxes ahead are removed.

On the normal production schedule, each of the more than 100 standard models is manufactured every two weeks. However, the layout of the new manufacturing plant permits change of the schedule at any time to meet a particular market demand.

Postdoctoral Research Associates Appointed At Bureau of Standards

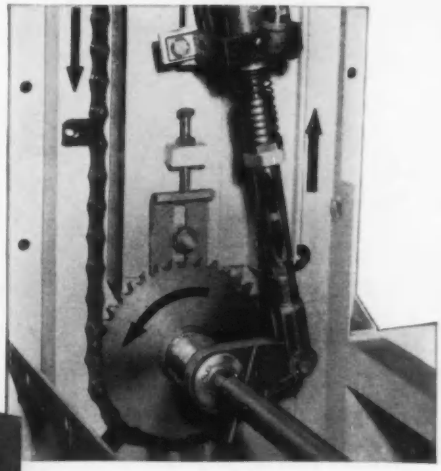
Five young scientists who have shown special promise of becoming creative leaders in basic research have been awarded Postdoctoral Research Associateships for advanced study at the National Bureau of Standards. The associateship program is sponsored jointly by the National Academy of Sciences, National Research Council and NBS.

The men, who have either received or shortly will be awarded their Ph.D. degrees, are scheduled to start work at NBS this year. They are: Earl C. Beaty, St. Louis, Mo.; Dr. Tucker Carrington, Aberdeen Proving Ground, Md.; Dr. Marvin Marcus, Vancouver, Canada; Robert A. Piccirelli, Washington, D. C.; and Wesley A. Robinson, Seattle, Washington.

The Research Associates will work under the direct supervision of scientists who are specialists in the associates' chosen fields. In addition to acquiring a wider basic knowledge, the Research Associates will have opportunities to work with and develop new scientific approaches and laboratory techniques. They also will be in close

(Continued on page 446)

Indexing Mechanism in Air-Maze Automatic Air Filter



...controlled by a Marquette SPRING CLUTCH

Air-Maze Corporation selected Marquette Spring Clutches to assure positive, trouble-free operation of its Automatic Air Filters. The metal filter forms an endless curtain, passing through an oil bath in the bottom of the assembly. Both the time cycle and the amount of travel can be varied as conditions require.

Marquette Spring Clutches are compact. They maintain their efficiency almost indefinitely. And they cost less than other types of clutches!

There are no restrictions on torque. Actual designs range from 6 in. lbs. to 25,000 ft. lbs. Speeds range from 1 to 10,000 r.p.m.

OVER-RUNNING or FREE-WHEELING CLUTCHES • INDEXING CLUTCHES
BI-DIRECTIONAL NO-BACK BRAKES • REVERSING CLUTCHES
SINGLE REVOLUTION CLUTCHES • DELAYED ACTION CLUTCHES

MARQUETTE METAL PRODUCTS DIVISION
CURTISS-WRIGHT
CORPORATION • CLEVELAND 10, OHIO

MARQUETTE METAL PRODUCTS DIVISION
1143 Galewood Drive, Cleveland 10, Ohio

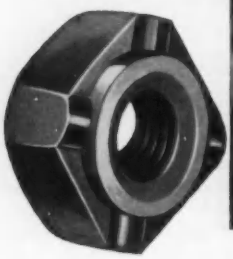
Please send manual describing the functions, applications and operations of the basic types of Spring Clutches.

COMPANY_____

NAME_____ TITLE_____

ADDRESS_____

SPEED UP THE FABRICATING, FASTENING AND ASSEMBLING OF METAL PARTS WITH



MIDLAND WELDING NUTS!

Midland Welding Nuts may be the answer to your dreams if you're in a business which fabricates, fastens, or assembles metal parts—OR, if you're a designer of products incorporating such parts.

Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

They're just the ticket for those hard-to-get-at places. And they stay put—will not work loose or rattle.

Relied on by manufacturers the world over—and specified universally by product designers—Midland Welding Nuts will lower your assembly costs, speed up operations all along the line for you.

Write or phone for complete information!

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Avenue • Detroit 11, Michigan
Export Department: 38 Pearl St., New York, N. Y.
Manufacturers of
Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

contact with other NBS scientists and the National and international scientific leaders with whom the Bureau is associated.

Postdoctoral study and research lasting for a year or more is a tradition among scientists. Many of the country's scientific leaders used such work to round out their education before settling on the field of research for which they are best known. In recent years the number of opportunities for such postdoctoral appointments has not kept up with the need; recognizing this, the National Academy of Sciences and the Bureau worked out the research associateship program to provide advanced training for promising young American scientists. The associateships were first announced in 1954.

This year some 20 areas of study at NBS were made available to applicants. They were: applied mathematical statistics, numerical analysis, pure and applied mathematics, experimental atomic and nuclear physics, experimental thermodynamics, fundamental problems in physical measurement and computer design, interaction of radiation with matter, low temperature physics, mechanics of fluids and solids, molecular structure and spectroscopy, radiological physics, radio wave propagation, solid state physics, statistical mechanics, visual psychophysics, physics and chemistry of polymers, and analytical, inorganic, organic, and physical chemistry.

G. E. Forum Discusses Missile Problems

Approximately 350 U. S. scientists and engineers met in open forum at Schenectady recently to discuss some of the most perplexing problems they face in their efforts to produce successful, long-range guided missiles.

According to R. W. McFall of General Electric's Special Defense Projects Department, the forum's host, the interchange of theories and experiences aired at the meeting may serve to hasten the solution of some of these problems, the foremost of which concern aerodynamic design and materials subjected to high velocity flight.

Papers were presented by three G.E. scientists and engineers engaged in

(Continued on page 449)

DESIGNERS:

Visit us when you vacation in NEW ENGLAND

you may be able to enjoy this better living all year long.

New England vacations are always lots of fun. But they can't compare with year 'round living in this pleasant countryside.

This year make your visit a double-duty visit. Plan to spend at least one day at our East Hartford headquarters. It's possible that you and your family will be able to enjoy New England living advantages twelve months a year.

Our jet engines have won tremendous international acceptance. As a result, we have innumerable openings at many levels. These are career openings — not just jobs. They all offer unusual opportunities for professional growth and advancement.

To further increase your professional development, a nearby graduate center, established in conjunction with Rensselaer Polytechnic Institute, offers training toward advanced degrees. Employees are eligible for substantial tuition assistance.

It is impossible to itemize all our tangible and intangible advantages. To learn more, mail the coupon immediately. Your telephone number is important since we may want to call you to arrange a meeting with our supervisors.

PRATT & WHITNEY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD 8, CONNECTICUT

World's foremost designer and builder of aircraft engines

Mr. E. M. Peterson, Dept. 7, Design Employment
Pratt & Whitney Aircraft, East Hartford, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

- ☐ Nuclear Design
- ☐ Compressors
- ☐ Turbines
- ☐ Structures
- ☐ Afterburners and Related Equipment
- ☐ Aerodynamics
- ☐ Hydraulics
- ☐ Gears
- ☐ Valves
- ☐ Heat Exchangers and Combustion Problems
- ☐ Bearings
- ☐ Piping
- ☐ Controls
- ☐ Test Equipment
- ☐ Test Rigs

Total years Mechanical Design experience.....

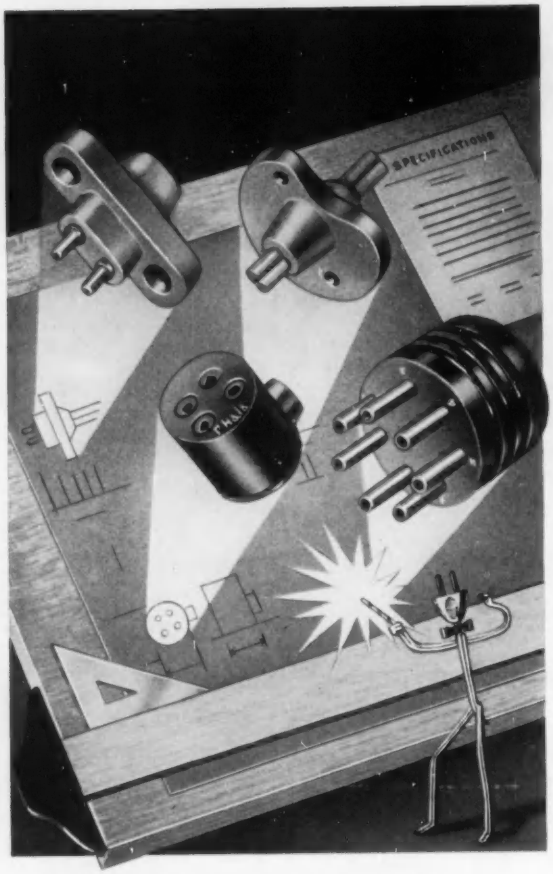
You can reach me at..... (home telephone) Most convenient hours for receiving calls are between.....and .....

NAME.....

HOME ADDRESS.....

CITY.....STATE.....

You Specify The Special Part...



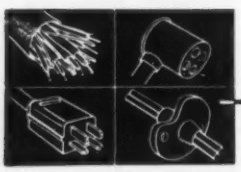
PHALO *Will Mold It!*

Electrical or Electronic . . . simple or complicated, Phalo will translate your specs to the minutest detail.

Take no chances! Follow the leaders and put your insulation specs in the hands of Phalo engineers.

Start by asking for the Phalo catalog.

• • •



PHALO

PLASTICS CORPORATION

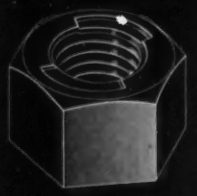
The Custom Cable House

21-25 FOSTER STREET

WORCESTER, MASSACHUSETTS

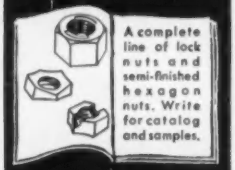
Insulated Wires, Cables – Cord Set Assemblies

LESS torque-scatter WITH THE M·F



(Production men, of course, know that a lock nut with a "scatter-pattern" interrupts production and increases rejects.)

. . . and constant-torque M-F costs NO MORE!



A complete line of lock nuts and semi-finished hexagon nuts. Write for catalog and samples.

Uni-Torque® **LOCK NUT**

Why do *designers* want a lock nut that shows an *even* pattern of torque, nut after nut, keg after keg?

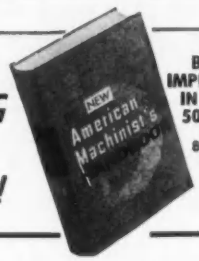
Because *it* means *uniform bolt tension*, which is important in keeping the finished product true to original design.

MAC LEAN-FOGG

Lock Nut Company

5535 N. Wolcott Street
Chicago 40, Illinois

Get the METALWORKING fact you want when you want it!



BIGGEST IMPROVEMENT IN NEARLY 50 YEARS!

80% rewritten
1579 pages
774 illus.
45 big sections

Here's outstanding news for all concerned with metal working in its technical planning and production stages. Now you can have a famous reference book of long-standing reputation, in entirely modernized form. THE NEW AMERICAN MACHINIST'S HANDBOOK brings you today's practice—today's needed data—in profusion. In it you will find 1579 pages of dependable facts to speed up and simplify your work in shop and drafting room.

The NEW American Machinist's Handbook

This handbook is so concisely written, so logically arranged, so packed with facts, that you'll find it of almost daily use in your work. Look up in it questions, large and small, on layouts, feeds, speeds, tools, jigs, fixtures, materials, standards, tolerances, forming and finishing methods—hundreds of details of machine shop and drawing room practice. You'll find the authoritative answers that will mean time and money saved and better results in all your work.

Edited by RUPERT LE GRAND Senior Assoc. Ed. American Machinist Based on AMERICAN MACHINIST'S HANDBOOK edited by Colvin and Stanley

FREE TRIAL! EASY TERMS!

McGRAW-HILL BOOK COMPANY, Inc. Dept. FPE-
327 W. 41 St., New York 36, N. Y.

Send me LeGrand's THE NEW AMERICAN MACHINIST'S HANDBOOK for 10 days' examination on approval. If satisfactory I will send (check one) ☐ $3 in 10 days and $3 a month until $11 is paid, or ☐ full purchase price of book. (We will pay delivery cost if remittance accompanies this coupon. Same examination return privilege.)

Name (print) .....

Address .....

City ..... Zone ..... State .....

Company ..... Position .....

For price and terms outside U.S., write McGraw-Hill Int'l., N.Y.C.

missile research. Current efforts to set up laboratory conditions to approximate outer atmospheric flight were described. It was noted that such research tools as the shock tunnel and the mass accelerator are being used to study atmospheric effects on such factors as metals, radio propagation and missile design.

According to G.E., this forum is the first of a continuing series to be sponsored by the Special Defense Projects Department.

Combination Noise Analyzer Introduced

A new electronic instrument to aid the fight against one of the country's most troublesome safety problems–industrial noise–has been introduced by Mine Safety Appliances Company, Pittsburgh.

The instrument is the first that combines in a single, portable unit four principal functions necessary to measure and analyze noise accurately. Acoustical engineers, industrial hygienists, safety directors, industrial designers, audiologists, city planners, speech experts and many others concerned with the problem can use the instrument to track down and measure hazardous noises.

Called the "Soundscope," the instrument serves as a sound level meter, as an octave band analyzer, and as a discrete frequency analyzer. The instrument is the first to combine these functions in a single package. Electrical and acoustical calibrators are built into the unit.

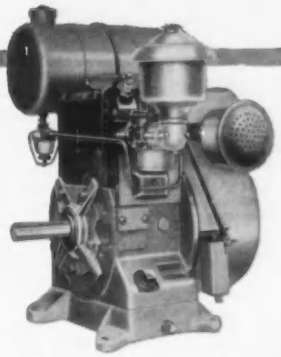
Because the instrument is portable, self-contained, simple to operate and incorporates necessary analytical features, its widest use will be in the field of industrial noise prevention to combat occupational loss of hearing. The American Standards Association reports that industrial noise has resulted in $2 billion worth of claims filed against industry.

Circuits and instrumentation of the unit meet pertinent specifications of the American Standards Association for sound level meters and analyzers. Each of the 14 tubes is mounted on a shock-absorbing pad and the first tube in each amplifier unit is encased in a metal shield. Sub-miniature vacuum tubes are used, along with printed cir-

(Continued on page 450)

Step up performance of your power equipment...with one of these

3 New Onan Engines



MODEL AJ

Single-cylinder, gasoline-powered

5.5 H.P.

A compact, rugged, high-performance engine developing 5.5 H.P. at 3600 R.P.M. For heavier-duty applications on construction machinery, farm and garden equipment and similar products. Four-cycle; air-cooled; L-head; vertical cylinder; 2¾" bore; 2½" stroke; 14.9 cubic inch piston displacement; 6.25:1 compression ratio. Removable aluminum alloy cylinder head; fully counterweighted and balanced crankshaft for smooth operation. High tension magneto ignition. Mounted fuel tank and muffler. Manual pull-rope starting (recoil starter or electric starting optional).

Overall dimensions: *Length (incl. shaft) 15⅛", height (with tank) 20"; Width 20¼".* ***Weight:*** *(Dry with accessories) 86 pounds.* ***Power take-off:*** *Crankshaft extension 3¼" long, 1" diameter.*

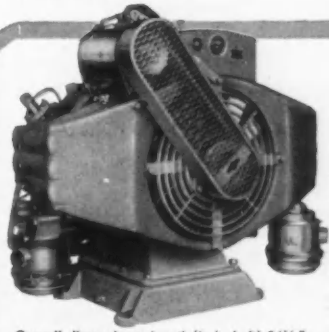
MODEL CCK

Two-cylinder, gasoline-powered

12.9 H.P.

Horizontal, two-cylinder opposed design gives this engine exceptionally smooth, quiet operation. Develops 12.9 H.P. with accessories at 2700 R.P.M. Pressure air-cooled; 4-cycle; 3¼" bore; 3" stroke; 50 cubic-inch piston displacement; 5.5:1 compression ratio. Extra-large bearing surfaces; high tension magneto ignition; governor regulation within 5%. Short, extra heavy crankshaft. Removable aluminum cylinder heads. Full pressure lubrication. Manual pull-rope starting. (Recoil starter optional).

Overall dimensions: *Length (incl. shaft) 14¾", Width 19½", Height 17⅞".* ***Weight:*** *(Dry, with std. accessories) 148 pounds.* ***Power take-off:*** *Crankshaft extension, 2 13/16" long, 1½" diameter.*



MODEL DRP

Two-cylinder, air-cooled Diesel

15 H.P.

Where heavy duty performance, economy and safety are important factors, this air-cooled full Diesel engine has outstanding advantages. Electric starting; horizontal, 2-cylinder opposed design; develops 15 H.P. with accessories at 2300 R.P.M.; 4-cycle; 3½" bore; 3½" stroke; 67.3 cubic inch piston displacement; 17.3:1 compression ratio; forged steel crankshaft and connecting rods; extra-large bearing surfaces; full pressure lubrication; 12-volt generator.

Overall dimensions: *Length (incl. shaft) 26⅛", Height 28", Width 30¼".* ***Weight:*** *(Dry, with accessories) 516 pounds.* ***Power take-off:*** *Flywheel for disc drive; accessory crankshaft extension 4" long by 1½" diameter.*

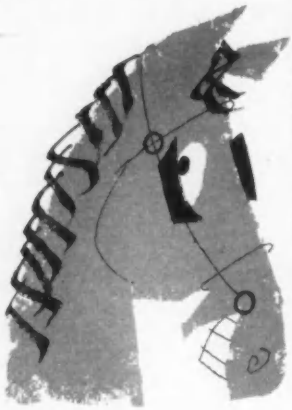
Write for complete specifications

D. W. ONAN & SONS INC.

Onan ELECTRIC PLANTS

4036 University Ave. S.E., Minneapolis 14, Minnesota

It's good Horse Sense to choose SPEER Carbon Brushes



You hold a pay-off ticket when you specify Speer application-tested brushes for any fractional horsepower installation. Every Speer brush is a performance-proved winner, tested in the laboratory and on the job to give you...

- EVEN WEAR
- IMPROVED COMMUTATION
- REDUCED VIBRATION
- LONGER BRUSH LIFE

Through 50 years of carbon and brush specialization, Speer has developed a broad variety of carbon and graphite brushes to meet the requirements of every type installation. *Write today for "Brushes by Speer"* containing valuable data on the characteristics and applications of Speer's complete line of brushes.

SPEER Carbon Co.
St. Marys, Pa.

Send catalog: "Brushes By Speer"
Name
Title
Address
City State

cuits, to reduce the size of the instrument as well as to prolong the service life of the seven dry-cell batteries that supply power. The entire instrument measures 16 in. long, 7¾ in. wide and 7 in. deep. It is enclosed in a wood and aluminum case that serves as a mechanical and electrical shield. All control dials are located on one panel and readings are indicated by a single meter.

When used as a sound level meter, the Soundscope picks up noise through its microphone which transforms sound into electrical energy. The sound pressure level is measured by passing the electrical signal through attenuators and amplifiers to the meter. The reading appears on the meter calibrated in decibels. Measurement range is from 24 decibels, about that of a very quiet home, to 150 decibels which is considerably higher in sound pressure than an air raid siren.

In the analyzer section of the instrument, noise is filtered into any of the eight principal octave bands, from 75 cycles to 19,200 cycles per second. Noise peaks in each of these bands then can be measured individually. For finer analysis, by frequencies within the octave bands, continuously variable filters are used. Importance of breaking sounds into frequencies to measure intensity levels is based on investigations which show that the ear is more susceptible to some frequencies than others. Thus, the offending frequencies can be accurately determined.

Railroad Research Facilities to be Expanded

Ground has been broken for the third building at the Association of American Railroads' research center on the Illinois Institute of Technology campus in Chicago. The $500,000 building—latest step in a long-range program to provide complete research facilities for the railroad industry—will be used primarily for rail, track, ballast, detector car, and structural research. The structure, designed by Ludwig Mies van der Rohe, will be the 22nd new building to be constructed at Technology Center—the

(Continued on page 452)

NEW METER-RELAYS
FROM 0-5 MICROAMPERES-UP
Ruggedized - Sealed, Black Bakelite or Clear Plastic Cases

D'Arsonval meters with locking contacts for sensitive and accurate control or alarm.

Model 461-C, 10-0-10 Ua DC $83.25

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact on moving pointer. The other on adjustable pointer. When pointers meet, contacts close and lock. Holding coil wound on moving coil. Locking is electro-magnetic. Manual or automatic reset. Spring action kicks contacts apart.

Ranges: From 0-5 microamperes, 0-5 millivolts or 0-300°F up.

Standard Contact Rating 5 to 25 milliamperes DC. Can be up to 100 milliamperes DC.

Ruggedized-Sealed metal cases, 2½", 3½" or 4½" round, shock-mounted movement, gasket-sealed.

Black Bakelite case, 4½" rectangular.

Clear Plastic cases, 2½", 3¾" or 4½" rectangular.

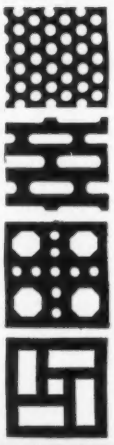
Model 255-C, 0-10 V DC $42.50

Panel meters and indicating pyrometers also in ruggedized-sealed, black bakelite or clear plastic cases. Write for new 40 page Catalog 4A on meter-relays, meters, pyrometers and automatic controls.

Assembly Products, Inc., Chesterland 55, Ohio. HAmilton 3-4436 (West Coast: Desert Hot Springs 55, Calif. Phone: 4-3133 & 4-2453).

DIAMOND PERFORATED METALS

Need Holes in Metal Sheets?



Several considerations must usually be observed. The design should be attractive in appearance and the percentage of open area should be adequate while, at the same time, affording suitable concealment of what lies behind or underneath. Naturally, also, the right metal should be used in the right thickness.

Whenever Perforated Metal is required, and it has thousands of applications today, you'll do well to contact Diamond. Forty years of widely diversified experience and hundreds of modern tool arrangements enable us to give unsurpassed service and delivery. Catalog 39 (32 large pages) gives complete illustrated information. No charge or obligation.

DIAMOND MANUFACTURING CO.
Box 40 WYOMING (Wilkes-Barre Area) PENNA.

Indiana Permanent Magnets
undergo **13** *quality and uniformity tests!*

. . to help maintain a steady flow on YOUR production line

. . to help reduce rejects on YOUR final product assemblies

World's Most Complete Line of Permanent Magnets!

all shapes . . all sizes . . all grades . . cast Alnico . . sintered Alnico . . Hyflux Alnico V . . ceramic Indox . . Cunife . . and other special magnet materials

Yes, Indiana Permanent Magnets undergo a wide range of tests . . Spectograph tests . . chemical analyses . . Zyglo tests . . 13 tests in all to assure precise magnetic characteristics, sound structure, exact physical dimensions . . in short, to assure uniformity and high quality.

Maintaining the high quality of Indiana Permanent Magnets is not just a one-man or one-department responsibility. Teams of physicists, engineers, technicians and experienced craftsmen supervise and keep a constantly critical eye on all stages of production. Quality control is this group's most important single job . . by far!

To be sure of better permanent magnets, take advantage of the experience of permanent magnet specialists. Indiana maintains the World's largest staff of engineers devoted solely to the design and application of permanent magnets . . the World's largest and most complete research and production facilities.

Indiana engineers, with almost a half century of experience in "tailoring" permanent magnets for more than 35,000 designs, will welcome the opportunity to work with your technical men in the development of your permanent magnet designs.

We invite you to contact your nearest Indiana sales engineer . . in Boston, HAncock 6-2323 . . in Chicago, FRanklin 2-1114 . . in Cleveland, CHerry 1-4163 . . in New York, VAnderbilt 6-1898 . . in Los Angeles, DUnkirk 4-0465 . . in Philadephia, KIngsley 5-2036 . . in Rochester, HAmilton 8990.

Write, today, for your copy of magnet catalog #11-C-6. This 8-page booklet details the wide range of Indiana cast permanent magnets available for immediate delivery in sample quantities.

. . Manufacturers of permanent magnets for the electronics, electrical, instrument and communications industries

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA
World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

JOT NAME, TITLE AND ADDRESS IN THIS SPACE
TO START YOUR FREE NELWELDER SUBSCRIPTION

Complete photo of this fighter pilot appears on the front cover of the June NELWELDER, industry's magazine of stud welding.
NELWELD

another way of saying..

JET-SPEED STUD WELDING DOWNS COSTLY FASTENING

A nationwide fighter group of Nelson field engineers stands alerted to help you attack soaring costs in your plant or on your building site. This jet-action NELSON® stud gun end-welds studs to steel . . . brings fastening costs down to earth by eliminating drilling and tapping, reducing handling, and cutting rejects.

Let a field engineer conduct a reconnaissance mission; then pinpoint strategic locations for stud welding on your product. In the meantime jot your name above and you will receive monthly issues of the NELWELDER, a magazine aimed at helping you spot production short cuts.

NELSON STUD WELDING
Division of Gregory Industries, Inc.
LORAIN, OHIO

name given to Illinois Tech's campus —since 1943.

One hundred and thirty-two railroads in the United States and Canada are members of the Association of American Railroads. Investigations at the research center are designed to promote safety, economy, and excellence of rail service to the public. The AAR research center was established on the Illinois Tech campus in 1950. Since then two buildings—an administration building and a mechanical engineering laboratory facility—has been constructed. The new structure will be of welded steel frame construction with areas of buff brick and large glass panels, similar to the other Mies-designed buildings at Technology Center. It is expected to be in operation by early 1957.

New Atomic Physics Chief At Bureau of Standards

Dr. Lewis M. Branscomb, a specialist in atomic physics research, has been appointed Chief of the Atomic Physics Section at the National Bureau of Standards. He had been Acting Chief of this section of the Atomic and Radiation Physics Division since 1954.

Dr. Branscomb will continue his direction of an experimental investigation of the properties of free negative ions and their interaction with photons, electrons, and other ions or atoms. A recent contribution in this work was the direct measurement of the binding energy and light absorption cross section of the negative ions of oxygen and hydrogen. In addition to this project, the Atomic Physics Section is also working on the precise determination of atomic constants, such as the gyromagnetic ration of the proton, and on the absorption of microwaves in gases.

Dr. Branscomb, who was born in Asheville, North Carolina, in 1926, was graduated from Duke University in 1945. He took graduate work at Harvard University, receiving his M.A. in physics in 1947 and his Ph.D in 1949.

When Dr. Branscomb came to the Bureau in 1951, he joined the Physical Electronics Section. This section was later renamed Solid State Physics and Dr. Branscomb was made Acting Chief. In 1953 he was appointed Assistant Chief of his present section.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED ——**RATES**—— **UNDISPLAYED**

The advertising rate is $22.20 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—8 columns—30 inches to a page.

Subject to Agency Commission.

$1.80 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Position Wanted ads are ½ of above rate.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of PRODUCT ENGINEERING, P. O. Box 12, N. Y. 36, N. Y., for July issue closing June 20th

Mechanical Engineer
OR
Mechanical Designer

Position open for Mechanical Engineer with 3 years minimum experience or for Mechanical Designer with 7 years minimum experience. Opportunities in layout and detail design for applied research and instrumentation.

Salary commensurate with training and experience. Excellent working conditions. Liberal vacation policy along with other fringe benefits. Unusual opportunity to carry on University graduate studies while working full time.

U. S. Citizenship required

Write, giving details of education and experience to:

Technical Personnel Representative
University of Michigan
Willow Run Laboratories
YPSILANTI, MICHIGAN

MECHANICAL ENGINEER

Position open for an engineer in the Reactor Development program of a large midwest research and development laboratory. This position is with a small group of engineers and physicists who to date have been responsible for some of the most outstanding and significant experiments in the field of nuclear power reactors. The opportunity to become a member of this team presents a real challenge to the young engineer with a strong academic background and preferably some general engineering experience. Salary is commensurate with training and experience.

P-1806, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

engineers
physicists

Leeds and Northrup Company wants to talk with you about Engineering openings in:

- **Application**
- **Sales Marketing**
- **Production**
- **Research & Development**

For over 50 years Leeds & Northrup has been the world's foremost manufacturer of Automatic Process Control and Scientific Electrical Measuring Instrumentation.

If you are seeking stability of employment, favorable salary schedules, unusual advancement opportunities plus other employee benefits commensurate with these high standards, write us today.

Build on your past experience in any of these fields:

★ Electrical Measurement & Control of Industrial Processing.
★ Power Generation & Transmission.
★ Servo Mechanism.
★ Digital & Analog Computers.
★ Combustion Control.
★ Nuclear Reactors.

Write for Details to—

Technical Employment Division

LEEDS & NORTHRUP COMPANY

4901 Stenton Avenue
Philadelphia 44, Pa.

ENGINEERS,
Electronic & Mechanical
PHYSICISTS:

Top Grade Openings

At Melpar *Leader in*

Electronic Research & Development

Due to our continuing expansion program, a number of top grade openings exist in our new laboratories suburban to Washington, D. C. We urge you to consider the following:

1. At Melpar the engineer is not tied to a pre-arranged schedule of advancement. Instead, promotion and advancement are based on *individual recognition*, where skill and ability are the paramount factors of determination.

2. Melpar has doubled in size every 18 months for the past 10 years. New openings occur constantly. This enables the engineer to advance to positions of increased responsibility *as soon as he is ready.*

3. Our unique "project team" basis of organization gives the engineer an opportunity to participate in *entire* problems from conception to completion of prototype, and thus experience the "overall" approach to engineering problems necessary to eventual directorship responsibility.

4. Our new air-conditioned laboratories encompass over 285,000 square feet and offer *complete* facilities for creative research and design. In addition to our central Model Shop, supplementary facilities, personnel and test equipment are available for *immediate* use within each project group.

5. The Northern Virginia Area, suburban to Washington, D. C., in which Melpar is located, offers excellent living conditions, enjoys the Nation's highest per capita income, fine homes and schools. Recreational, cultural and educational facilities abound. Fully-accredited graduate courses are offered at the Melpar laboratories and at 5 universities in the Area.

Top Grade Openings Exist in These Fields:

Network Theory • Systems Evaluation • Microwave Technique • UHF, VHF, or SHF Receivers • Analog Computers • Magnetic Tape Handling • Digital Computers • Radar and Countermeasures • Packaging Electronic Equipment • Pulse Circuitry • Microwave Filters • Flight Simulators • Servomechanisms • Subminiaturization • Electro-Mechanical Design • Small Mechanisms • Quality Control and Test Engineering

Write for complete information. Qualified engineers and physicists will be invited to visit Melpar at Company expense.

Write: Technical Personnel Representative

MELPAR *Incorporated*

A Subsidiary of Westinghouse Air Brake Company

3095 Arlington Boulevard, Falls Church, Virginia

Positions also available at our laboratories in: Cambridge, Mass., 99 First St., Watertown, Mass., 11 Galen St.

DESIGN ENGINEER

Position open for mechanical engineer with B.S. Degree and minimum of five years' experience in design of engine test equipment. Position involves design of engine test apparatus. Must be thoroughly familiar with machine shop practice and methods and have ability to follow construction of design projects through to completion. Send resume of qualifications to: Ethyl Corporation Research Laboratories, 1600 West Eight Mile Road, Ferndale 20, Michigan, attention: Personnel Manager.

PRODUCT STYLING SALES EXECUTIVE

One of the largest industrial design organizations in New York has an opening for a sales executive to contact nationally known manufacturers regarding product styling. He should have the following background and characteristics:

Substantial experience in marketing, advertising, and merchandising. Knowledge of materials and manufacturing techniques and ability to use this experience effectively. Creative, imaginative and inventive, yet practical. Able to verbalize ideas rapidly whether oral or written.

Ability to understand motives of others and to size up complicated human relations situations. Enjoy contact work and find persuading others rewarding. Able to work with sustained concentration and to pay proper attention to both details and the overall aspects of the job. An effective organizer and administrator able to grow into a position of top level responsibility and decision making.

Our staff knows of this ad. Replies will be held in strict confidence.

P-1580, Product Engineering
330 W. 42 St., New York 36, N. Y.

MECHANICAL ENGINEER

Position open in Operations Division of a midwest research and development laboratory for a graduate with a minimum of five years experience in the design and construction of mechanical facilities, including industrial type air conditioning, ventilating and heating systems; process piping, and pneumatic control systems for a wide variety of equipment installations; and water and steam distribution systems. Duties include the obtaining of operational and other design requirements for the construction of new facilities and the rearrangement of existing facilities; preparation of designs, specifications, and cost estimates; and performing field inspection of construction contracts. Salary commensurate with training and experience.

P-1810, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

DESIGN ENGINEERS

A well established, progressive manufacturer of business forms, mechanical and electronic auxiliaries to business machines, and a leader in Office Automation has permanent positions available in these areas: electromechanical, tool, machine and mechanical product design. Excellent employee benefits and advancement opportunities. All replies kept in strict confidence. Send resumes to: Professional Employment, The Standard Register Co., Dayton 1, Ohio.

PRODUCTION ENGINEER
MECHANICAL ENGINEER
TOOL DESIGN ENGINEER
ELECTRICAL ENGINEER
(ENVIRONMENTAL TESTING)
DEPRESSION PROOF INDUSTRY

Expanding medium sized electrical component manufacturer in the Chicago area offers excellent potential for personal growth and recognition for competent and experienced engineers under 40. Degrees in M.E. or E.E. necessary. Direct all replies and personal resumes to:

John M. Mendheim Ind. Rel. Mgr.

OHMITE MFG. CO.
3601 W. HOWARD STREET
SKOKIE, ILLINOIS

ADVERTISING MAN WANTED FOR TECHNICAL PRODUCTS

Previous advertising experience not necessary but helpful. Must have at least two or three years of college with courses in engineering and technical subjects and like to write. If you have the qualifications we have an opportunity open for you. Man selected will be trained in all phases of industrial advertising. In your letter of application state age, education, positions held, and give statement of why you want a career in advertising. Location: well-known Connecticut company.

P-1211, Product Engineering
330 W. 42 St., New York 36, N. Y.

MECHANICAL ENGINEER

Position open for a design engineer in the Central Shops facility of a midwest research and development laboratory. Ability to design and follow through fabrication on a wide range of scientific equipment for use in research in Physics, Chemistry, Biology, Chemical Engineering and Metallurgy. Salary commensurate with training and experience.

P-1808, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Fort Wayne, Ind.
"America's Happiest City"

Dear Bill:

Now that Joe is on the team here at Farnsworth, he's asked me to write and give you the same story that got him interested in coming with us.

Actually, Bill, it wasn't a "story." Just a few honest-to-goodness reasons why he and Marge should make the move and let the family really live as well as let Joe grow professionally.

For instance, do you know what "sold" Marge? The fact that in living here you are only 10 minutes from everywhere—schools, churches, stores etc. and Joe goes home for lunch every day instead of week-ends. She also liked the idea of some 300 lakes within 70 miles. (Guess where they're planning to spend the summer!)

As for Joe, he's all hepped up about the work he's doing on such missiles as Bomarc, Talos, Terrier and others. Says the top-notch scientists and engineers he's working with are all big-league and he's on the team.

That's about it, Bill. An engineer with your talents shouldn't be waiting around when he can get in on the ground floor here at Farnsworth in research, development or production engineering in missile guidance and control, radar, microwaves, test equipment, countermeasures, transistor applications etc.

So—why not write, right now to Don Dionne, Farnsworth Electronics Co. Fort Wayne, Ind. (a division of International Telephone and Telegraph Corp.)

You, Joe, I and Farnsworth will be mighty glad you did.

Sincerely, Jack

EXPERIENCED DESIGNERS-LAYOUT MEN

TO WORK AT

GENERAL MOTORS NEW TECHNICAL CENTER

For Experimental Automotive Work in Transmissions, Engines & Chassis.

The Engineering Staff is located in the suburbs of Detroit on an 912 acre site devoted to research and development work. Splendid opportunity for men looking toward the future. Ideal working conditions in well lighted, air conditioned office building. Fine recreational program with golf course adjacent to site. Opportunity to become a share holder in GM through a generous Stock Purchase Program. Also excellent health insurance, life insurance, and retirement plans.

State full particulars: Age, Experience, Salary Expected, Etc. Send resume to:

PERSONNEL DEPT.
ENGINEERING STAFF
GENERAL MOTORS CORPORATION
G. M. Technical Center **Detroit 2, Mich.**

APPLICATION ENGINEER

Prominent manufacturer located Midwest has excellent opportunity for man with at least 3 years experience in internal combustion engine application engineering as related to fluid flow design of cooling water, lubricating and fuel oil, and air piping in power plants. Must have ability to calculate size of auxiliary pumps, coolers and so forth. Some knowledge of machine design and engineering mathematics essential. Must be able to handle all application engineering required by engine contracts. Write stating age, experience, and salary expected. Replies strictly confidential.

P-1357, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

MECHANICAL ENGINEER

Position open for a design engineer in the Remote Control Engineering Division of a midwest research and development laboratory. Challenging opportunity requiring ingenuity and imagination in the design of intricate mechanisms for remote controlled metal cutting machines, test apparatus, shielded facilities and manipulators. Publications encouraged. Salary commensurate with training and experience.

P-1804, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

WANTED
SECTION ENGINEER

$8,000.00 to $15,500.00. Small electrical motors. Age to 55. Supervise: Development, design, manufacture, cost control, customer contact, and application of small fractional and/or electric motors and motor parts to: manufacturers of portable hand tools, for use in portable hand tools and/or aircraft products. Must have a minimum of 5 years experience in electrical motors. A permanent position. It can lead to that of engineering manager, with a leading midwest manufacturer. Send two (2) copies of employment history in resume form. State salary wanted. **Confidential. No obligation.** In reply, refer to position number J-9161. Write to: C. R. Linsdon Company, 19 W. Jackson Blvd., Chicago 4, Illinois.

TAKE—KEEP—TELL—A—FRIEND

MECHANICAL ENGINEER

For design and development work on Rotary Positive Displacement Pumps. One of our clients, a prominent, progressive Chicago manufacturer has requested us to locate qualified candidates for a position which has exceptional potential for advancement. Interviews can be arranged in your vicinity. Reply by letter only to

FRED H. EBERSOLD, INC.
20. N. Wacker Drive, Chicago 6, Illinois.

MACHINE DESIGNER

Excellent opportunity for creative thinking. Scope to carry thru to completed equipment on automatic mechanical and hydraulic plant machines. Located in the ¾ million population Denver region, yet only 1 hour to Colorado rockies' hunting, fishing and skiing areas.

COORS PORCELAIN CO.
Golden, Colorado

SALARIED POSITIONS

$6,000 to $30,000

Hi-grade Engineers and Executives in all fields of industry.

GLOBE EMPLOYMENT SERVICE
42 S. 15th Street Philadelphia 2, Pa.

SENIOR MATHEMATICIAN

Masters or P.H.D. Approximately four years experience in an electronics industry, a good knowledge of differential equation and methods of replace, who will work under the direction of the director of engineering. The salary is in the $8,000-$11,000 per year bracket. Company pays agency fee and relocation expense.

Monarch Personnel **28 E. Jackson Blvd. Chicago 4, Ill.**

CHIEF PRODUCT ENGINEERS

$10,000-$15,000

(2) Turbine compressor or gas engine experience.
(1) Heavy and light portable tools.
(1) Heavy construction equipment.

Send complete resume to:

J. J. COOPER
64 E. Jackson Blvd. **Suite 940**
Chicago, Ill. **Wabash 2-1918**
PROMPT AND CONFIDENTIAL SERVICE.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION WANTED

Electrical design engineer with design and development experience and several years' experience as a practicing patent attorney wishes to obtain lucrative employment adjacent to or around New York City. Write PW-9504, Product Engineering.

WANTED

ANYTHING within reason that is wanted in the field served by Product Engineering can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

Individual spaces with border rules for prominent display of advertisements.

The advertising rate is $16.85 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

UNDISPLAYED RATE

$1.80 a line, minimum 3 lines.

To figure advance payment count 5 average words as a line.

Box Numbers—Care of publication count as one line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Equipment Wanted or For Sale Advertisements acceptable only in Displayed Style.

ALUMILITED ALUMINUM

Flat & Embossed SHEETS

Die formed panels used for store fronts, signs, trailers, displays, dryers, etc.
Anodized sheet supplied for all purposes.

LUSTRIK, Inc. Reg. T.M.
3235 Frankford Ave. Philadelphia 34, Pa.

CATALOG PREPARATION SERVICE

Give us the raw data. We'll organize it according to your criteria, prepare dummy, produce finished art and supervise printing—or do any part of the job. Our catalogs are among the best-looking and easiest-to-use. Estimate in advance. Service area: New England, N. Y., N. J., Penna. & Delaware.

MILTON HERDER, Industrial Advertising
55 W 42nd St., New York 19 **BRyant 9-1963**

PROFESSIONAL SERVICES

ARNOLD E. RUDAHL

Electro-mechanical Product Engineering

- Magnetic devices, synchro, servo, control components, specific-performance motors, from appliance drives to automation instruments.
- Custom-designed, specification, technical procurement.

Co-ordinated development of component, system and equipment. Prototype and engineering quantity production.

527 East Putnam Ave. Greenwich, Conn. Tel.: 8-7995

WILLARD F. MASON

Consulting Electrical Engineers

Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities

180 Post Road, Darien, Conn. Oliver 5-9039

"By reason of special training, wide experience and tested ability, coupled with professional integrity, the consulting engineer brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accumulators 61

Actuators
Electrical 406
Hydraulic 416
Mechanical 47, 393

Adhesives 74, 114

Air Motors (see Motors, Air)

Aluminum Alloys 79, 127, 247-250, 343-345, 435

Aluminum Coated Sheet and Strip (see Steel, Coated)

Assemblies
Electrical 272, 466
Hydraulic 263
Pneumatic 263, 290-291

B

Bars
Metal 28-29, 79, 112, 128, 423

Bearing Materials 71, 296

Bearings
Ball 15, 72, 105, 134, 225, 237, 298, 322, 355-356, 358, 379, 416
Miniature 379
Needle 72, 237
Oil-less 71, 218, 279
Roller 15, 69, 72, 124, 233, 237, 322, 379
Self-Lubricating 406
Sleeve 71, 218, 273, 279, 423, 440

Bellows 261

Belt Lacers 395

Belts 66, 278, 300

Belts, V 66, 98-99, 278, 308-309

Bi-Metal 31

Blowers 364, 374, 420, 444

Bolts 60, 288, 324, 352, 428

Boosters 61, 416

Brake Motors ..... 3rd Cover

Brakes
Electric 420, 436
Hydraulic 294
Mechanical 294

Brass 90, 127

Bronze 265, 406, 435

Brush Holders 272

Brushes, Electrical 272

Bushings 273, 406, 423

Bushings, Strain Relief 408

C

Cable 401

Cams 457

Carbon 48-49, 314, 450

Carbon Parts 279, 314, 440, 450

Carburetors 408

Casters 363

Castings 16, 20-21, 399

Castings, Precision Investment 64

Ceramics 77

Chains
Bead 444
Conveyor 13
Roller 13, 334, 355-356, 371
Silent 13, 355-356

Continued on p. 458

by Parker

In Automation . . . Instrumentation . . . Supersonic Aircraft—wherever true automatic control is needed, 3 dimensional cams by Parker can literally make machinery "think". By controlling relative motions through geometric and non-geometric curves, these mechanical "brains" take virtually any two variables and extract the correct functional resultant in a split second. Parker machines ultra precision into thousands of specified cam stations *and to all intermediate points between stations!* For prototype, master or production runs of 3 dimensional cams—you devise the problem, Parker will engineer and machine the answer!

Send today for "3 Dimensional Cams"—technical data on Parker's ability to make superhuman functions automatic.

THE PARKER STAMP WORKS, INC.
CAM DIVISION
FRANKLIN AVENUE • HARTFORD, CONNECTICUT

by Parker

Paragon® gives you speed . . . without fatigue!

Check the response-to-the-touch. You can actually feel the difference!

That's why the Paragon Drafting Machine noticeably cuts end-of-the-day fatigue . . . saves costly man hours . . . helps raise working standards.

See how easily protractor control ring can be reached—no matter what position your hand is in. Another time saver. Touch that ring with your *little* finger and scales rotate freely. Release pressure and scales automatically lock to nearest 15° position. And intermediate angles are just as easily set!

Top day-to-day performance is guaranteed by unique "open center" design of arms which protects smooth-working factory-set band tension.

A good look at a Paragon and a touch on that control ring is worth 1,000 words! Try it before you buy *any* drafting machine—you can *feel* the difference.

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles • Seattle • Montreal

Index of

PRODUCTS ADVERTISED

In This Issue

•

Continued from page 457

Chemical Treatments 240, 378
Circuit Breakers 439
Clad Metals 244
Clamps 441
Clamps, Hose 342
Clutches
  Electrical 120, 420, 436
  Hydraulic 246
  Mechanical 246, 325, 347, 412, 445
Coatings 8, 114, 254-255, 378, 392, 430, 436
Cold Headed Parts 352
Collector Rings 272
Compressors 330
Connectors
  Electrical 401
  Hose 85, 391
  Tube 85, 391
Contactors 40
Contacts & Contact Materials 272, 372, 394
Controllers 40, 414
Control Motors 115
Control Panels & Switchboards 40, 107, 389-390
Controls
  Electrical 32, 40, 107, 370, 389-390
  Hydraulic 88, 263, 269, 404
  Mechanical 348, 430
  Pneumatic 26-27, 263, 269, 404
Conveyor Belts 413
Copper & Copper Alloys 235
Cords 110-111, 415
Cork Compositions 57, 276
Counters 17, 406, 430
Couplings (see Connectors, Electrical)
Couplings
  Hose 263, 391
  Hydraulic 256, 398
  Mechanical 256, 405
  Tube 263, 391
Cylinders
  Hydraulic 44, 61, 269, 302, 416
  Pneumatic 44, 61, 269, 302, 416

D

Decalcomanias 416
Diaphragms 404
Die Castings 262, 334, 411, 421
Dies 282
Drafting
  Machines 283-286, 338, 375, 458
  Supplies 283-286, 338, 351, 408, 458
Drives
  Adjustable Speed 326
  Hydraulic 310-311
  Right-Angle 421
  Timing 417
  Variable Speed ..... 3rd Cover, 26-27, 59, 65, 73, 323

Index of

PRODUCTS ADVERTISED

In This Issue

•

E

Electrical & Electronic Components, Custom Made (see also Production Services) 299
Electrochemical Finishes & Treatments 392
Enamel 392
Engineering Services (see also Production Services) 50, 87, 130, 240
Engines 220, 449
Engravers 388
Expanded Metals 340
Extrusions
Metallic 2, 79, 109, 127, 265, 428
Non-Metallic 77, 318, 352, 412

F

Fabricated Plastics (see Plastics, Fabricated)
Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)
Fabrics, Coated 39
Facings, Clutch 300
Fastening Methods 97, 132, 260, 295 303, 327
Felt 383, 414
Fibre 104
Filters
Air 290-291, 327, 429
Hydraulic 327, 429, 467
Fittings, Hose, Pipe & Tube 391
Flexible Couplings 243, 432
Flexible Shafts 227, 430
Float Operated Switches 459
Forgings 79, 247-250
Friction Materials 276, 300, 426

G

Gages, Pressure or Vacuum 350
Gaskets 57, 92, 398
Gear Motors (see also Motor Reducers) ..3rd Cover, 59, 83, 91, 323, 374
Gears 1, 229, 251, 267, 281, 312, 357
Generators
A-C 396
D-C 396
Glass 407
Graphite .....4th Cover, 48-49

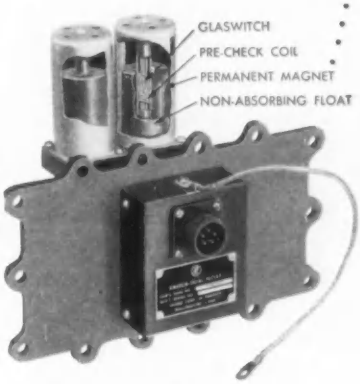
H

Hard Surfacing 254-255
Heat Exchangers 65

Continued on p. 460

Check and double check your level WITH

F-8480 weighs only 1.75 lbs. . . . operates 1.05" to 4.90" range . . . from —65 to 160 deg. F. Includes two hermetically sealed relays, SPDT, 3 amp motor load at 28 volts DC, 100,000 cycles minimum. Conforms to MIL Specifications. Heater unit (extra) for extreme temperature-humidity conditions.



F-70140 weighs 1.50 lbs. . . . for —65 to 160 deg. F. use. Contains one DPDT hermetically sealed relay. Rating—2½ amp at 28 volts DC, 100,000 cycles minimum. Precheck coils permit testing of switch when tank is dry. Conforms to MIL Specifications.

REVERE

DUAL FLOAT SWITCHES

Revere dual float switches have multiple applications. Used for automatic cut-off control in refueling operations, remote indication of fuel or fluid level in tanks, automatic C.G. control to actuate pumps or valves.

Revere Dual Float Switches allow use of two separate systems either as emergency or two-level control. Floats are only moving parts . . . non-absorbent for long-time accuracy. Permanent magnets in float actuate hermetically sealed Glaswitch* at precise levels. Vibration-proof, slosh-proof. Many types available.

* Trademark

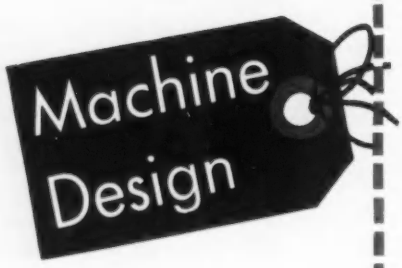
Ask for Engineering Bulletins 1050 and 1051 describing Revere Float Switches.

Revere CORPORATION OF AMERICA 19

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company

Machine Design ENGINEERS:

Tie in with the fast-growing electronic computer field!



APPLY your engineering ability to a stimulating position at IBM, where your growth is virtually unlimited.

IBM OFFERS YOU MORE:

First, a career in what is perhaps the one "unlimited" field in electronics.

IBM is builder of the world's *largest* computer!

Second, the vantage ground of IBM leadership.

IBM leadership is based on a record of solid achievement and growth. During 1955, IBM announced a major data processing improvement on the average of *every two weeks*. IBM Engineering Laboratory personnel increased five-fold in the past five years!

Third, excellent salaries and benefits.

Personnel turnover is less than one-fifth of the national average!

Fourth, advancement based solely on merit.

IBM engineers work in small teams, where individual contributions are quickly recognized and rewarded!

PRODUCT DESIGN

Develop complex, high-speed mechanisms, gear trains, cams, linkage systems.

Design packaging for unitized and miniaturized assemblies and printed wiring.

Evaluate functional performance of mechanical units by measuring motion, stress, strain, shock, etc., with oscilloscope, stroboscope, strain gauge, high-speed photography and other precision techniques.

TOOL DESIGN

Analyze tooling requirements and design new tools for production and assembly of precision parts.

MANUFACTURING RESEARCH

Develop new methods for production of complex precision parts.

Develop automated production assembling and testing machinery.

If you are interested in considering these opportunities, **write,** describing your background, to W. M. Hoyt, IBM, Room **706,** 590 Madison Avenue, New York 22, N. Y.

IBM Laboratories and Manufacturing Plants are located in **Poughkeepsie, Endicott and Kingston, N. Y., and San Jose, California.**

DATA PROCESSING
ELECTRIC TYPEWRITERS
MILITARY PRODUCTS
TIME EQUIPMENT

IBM® INTERNATIONAL BUSINESS MACHINES CORPORATION

Index of PRODUCTS ADVERTISED

In This Issue

Continued from p. 459

Heating Units 100
High Temperature Alloys..... 268
Honing Machines 274
Hose & Tubing.....85, 259, 263
Hydraulic Fluids 94, 335

I

Inspection Equipment 257
Insulation.....331, 354, 448

L

Lacquer 392
Laminated Plastics (see Plastics, Laminated)
Low Temperature Melting Alloys.... 444
Lubricants 75
Lubricating Equipment 41, 293

M

Magnesium Alloys 428
Magnetic Materials 106
Magnetos 297
Magnets 106, 451
Metal Bonded to Plastic..... 385
Moldings
Glass (see Glass Parts)
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Molybdenum Alloys 397
Motor Starters 40, 370
Motors, A-C
Fractional.....3rd Cover, 11, 22-23 38 42-43, 70, 103, 122-123, 253, 266 354, 359, 374, 382, 396, 398, 403 427, 444, 464
Integral.....3rd Cover, 11, 22-23, 42-43 52-53, 70, 122-123, 253, 266, 323 359, 382, 396, 398, 403, 444
Sub-Fractional...22-23, 292, 354, 374, 382
Motors, Air 330
Motors, D-C
Fractional....22-23, 38, 42-43, 67 A & B 70, 103, 122-123, 253, 266, 354 359, 374, 382, 396, 403
Integral...22-23, 42-43, 52-53, 67 A & B 70, 122-123, 253, 266, 323, 359 382, 396, 403
Sub-Fractional.....22-23, 354, 374, 382
Motors, High Frequency
Fractional 374
Sub-Fractional 374
Motors, Hydraulic.....117, 310-311

Index of

PRODUCTS ADVERTISED

In This Issue

N

Name Plates 416
Nickel Alloys 14
Nuts.....12, 51, 55, 60, 81, 97, 108, 132 288, 324, 352, 404, 428, 448

O

Optical Parts 458

P

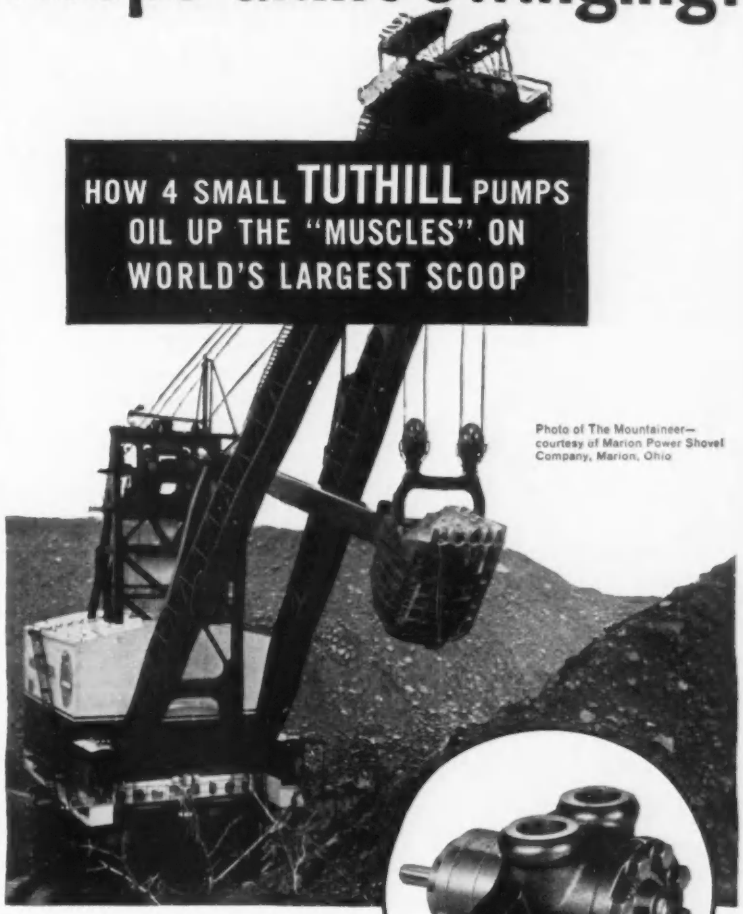
Packings.....94, 384, 386, 409, 424
Paper 365
Perforated Metals 450
Phosphor Bronze 410
Pillow Blocks.....15, 355-356
Pilot Lights 40
Pins 108, 410
Pipe 112
Plastic Film 67
Plastic Parts....24-25, 130, 299, 318, 346 428, 470
Plastics.....18-19, 24-25, 33-34, 82, 87 319-321, 346, 349, 412, 470
Plastics Fabricated 369, 428
Plastics Laminated 84, 252, 369, 470
Plates 28-29
Plates, Clutch 412
Porcelain 125
Powdered Metal Parts...4th Cover, 48-49 71, 218, 262, 423
Power Packs
Hydraulic 117, 269, 404
Power Take-offs 412
Precious Metal Alloys..... 372
Presses 88, 351
Pressure Switches 301
Production Machines & Processes 254-255, 303, 337, 387, 420
Production Services (see also Engineering Services)..87, 251, 299, 373, 466
Protective Devices, Motor..... 30
Pumps
Air 327, 330, 394
Liquid.....310-311, 327, 362, 388, 405 437, 461, 468
Vacuum 327, 330, 394

R

Ratchets 251
Regulators
Pneumatic 290-291
Relays.....40, 216, 264, 315, 346, 426 434, 443, 450

Continued on p. 462

Keeps Giant Swinging!



HOW 4 SMALL TUTHILL PUMPS OIL UP THE "MUSCLES" ON WORLD'S LARGEST SCOOP

Photo of The Mountaineer—courtesy of Marion Power Shovel Company, Marion, Ohio

To assure dependable flood lubrication on the swing gear units of this 2600-ton power shovel, Marion engineers selected Tuthill Model L positive displacement, internal-gear rotary pumps to do the job.

It was this type of Tuthill pump that pioneered the first practical mechanical seal for leak-free performance and low power consumption. Since 1927, hundreds of thousands of these compact small pumps have demonstrated their dependability to hold prime, deliver capacity needed, and operate quietly and uninterruptedly.

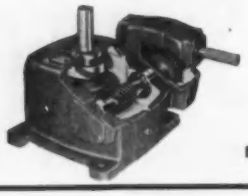
Whether your production calls for standard pumping units or special pumps for engineered applications in lubrication, coolant, hydraulic or liquid transfer service, you are invited to submit your specifications for recommendation.

Write for catalog data for lubrication or other specific needs.

See our catalog in Sweet's Product Design File 6b-Tu

TUTHILL PUMP COMPANY
Dependable Rotary Pumps . . . since 1927
939 East 95th Street, Chicago 19, Illinois

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada



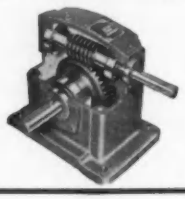
DPL

Ohio Double Speed Reducer DPL

Double reduction in DPL series is obtained by adding an attachment case to PL single reducer. Three sizes Nos. DPL-1-2-3. Ratios, 100-1 to 4000-1. Torque capacity, 900 in. lbs to 5800 in. lbs.

Ohio Speed Reducer HU Series Worm on Top

Single reducers. Same as HS series except input shaft is above and output shaft below. Includes 5 sizes, HU-0-1-2-3-4. Ratios, 5-1 to 100-1. Output shaft may extend to right, to left, or both right and left.



HU

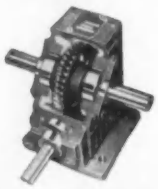
DOX
DOT

Small Horizontal Double Reducer DOX and DOT

An extremely sturdy and versatile reducer of the "baby" size, measuring 4 5/16" in length; 3 7/16" in width and 4 1/8" in height. Ratios, 4-1 to 1600-1. Torque capacities 25 in. lbs. to 150 in. lbs. Four shaft assemblies. Both speed reducers identical except DOX has Zinc-based alloy housing for economy and DOT has aluminum housing.

Small Horizontal Single Reducer BHS

Single reduction unit of the HS type. Right angle drive with input shaft below and output shaft above. Dimensions: 4-3/4" long, 3" wide and 6-1/8" high. Shaft extensions: 1-5/8". Ratios: 6:1 to 58:1. Hp from 1/8 to 5/8 depending on ratio.



BHS

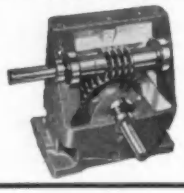
D

Ohio Double Speed Reducer D Series

For heavy duty service, Nos. DOT and D-1-3-4-5-6. Radial thrust bearings on high speed shaft, tapered roller bearings on all others except number DOT, which is equipped with tapered roller bearings throughout. Ratios to 3200 to 1. Torque capacities, 25 to 12000 in. lbs.

Ohio Speed Reducer BHU

BHU is the smallest single reducing unit in the Ohio Gear Line. Its dimensions are: height, 5 5/8"; length, 5 3/8"; width, 3". Shaft extensions are 1 3/4". Ratios 10-1 to 48-1. 1/4 to 3/8 H.P. depending on ratio. Input shaft on top. Output shaft may extend to right, to left or both right and left.



BHU

OHIO "OFF THE SHELF"

Ohio Speed Reducers have been enthusiastically accepted among nationallly known manufacturers for their sound engineering, sturdy construction and long economical operation. The various lines offer a variety of sizes, ratios and capacities to meet the widest range of power transmission requirements. Ratios from 4-1 to 3200-1.

The unique construction of Ohio Special Reducers permits the assembly of many additional ratios where stock ratios are not suitable. Special units also may be manufactured to fit individual applications. See your nearest distributor — or write direct.

ESTABLISHED 1915

OHIO GEARS

OHIO GEAR COMPANY • 1325 East 179th Street • Cleveland 10, Ohio

Index of

PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 461

Reproduction Equipment.....283-286, 361, 375, 458
Reproduction Supplies...283-286, 361, 458
Resins 366, 401
Resistors 4
Retaining Rings 45
Rheostats 4
Rivets 51, 97, 288, 303
Rod Ends 36
Rods
Metallic 79
Non-Metallic 252
Rubber ..2nd Cover, 50, 113, 239, 305, 339
Rubber Parts.....2nd Cover, 352
Rust Proofing 8

S

Screw Fasteners 433
Screws..60, 68, 108, 242, 288, 324, 352, 404
Screw Thread Inserts..... 433
Sealers 114
Seals.....78, 280, 336, 384, 386, 396, 404
Shapes, Rolled Formed..... 86
Sheaves 66, 98-99
Sheets
Metal.....28-29, 79, 112, 244, 258, 275
Plastic 24-25, 252
Shims 353
Silicone Rubber 96
Silicones 101-102
Slides 76
Solenoids 40, 386, 394
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) 51, 56, 97, 108, 132, 287, 324, 341, 404, 428, 441, 448
Speed Reducers.....93, 312, 384, 412, 462
Splines 47
Springs 425, 465
Sprockets.....13, 251, 271, 334, 371
Stampings.....281, 299, 342, 386
Steel
Alloy.....20-21, 28-29, 46, 54, 62-63, 231, 268, 431
Carbon 46, 268, 307
Coated 46, 275
Stainless.....28-29, 54, 112, 258, 268, 275, 329, 376, 431
Textured 275
Tool 54, 268
Strainers 327
Strip, Metallic.....112, 244, 275, 410
Studs 260, 452
Switches.....40, 332, 346, 357, 389-390, 419
Swivel Joints 245

Index of

PRODUCTS ADVERTISED

In This Issue

T

Terminals & Terminal Boards..... 333
Testing Machines & Equipment..... 257
Thermostats 35, 261, 367
Timers.....40, 89, 116, 264, 360, 377, 443
Timing Motors.....241, 264, 360
Titanium 28-29
Tools 410
Tracing Cloth 408
Transmissions.....126, 310-311, 368
Traps (Steam) 270
Tubing
Flexible Metal 85
Lock-Seam 289
Plastic 252, 306, 318
Seamless 58, 79, 317, 438
Welded 10, 79, 317

U

Universal Joints 304, 316

V

Valves
Air.....6, 269, 277, 290-291, 381, 463
Hydraulic.....6, 44, 121, 269, 277, 313 381, 414, 463
Solenoid 381
Vibration Dampers
Mechanical 243
Vibrators 328
Vibratory Equipment 328

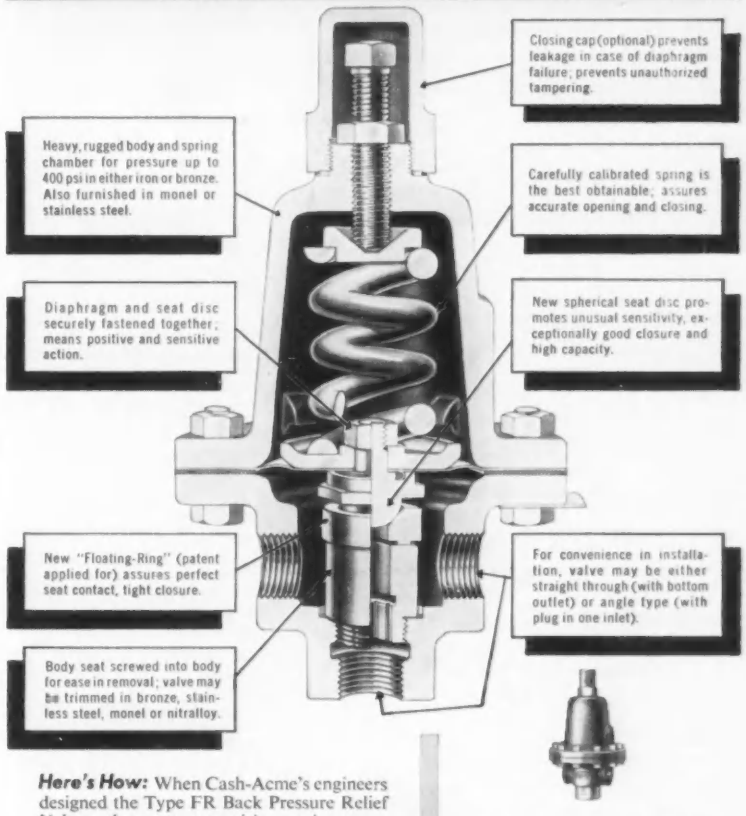
W

Washers.....273, 288, 295, 342
Washers (see Packings)
Wear Materials 406
Welding
Equipment 364, 442
Nuts 424, 446
Supplies 364, 452
Wheels 436
Whiteprinting Equipment 432
Wire.....37, 95, 112, 299, 402, 438
Wire & Cable..... 415
Wire Cloth 95, 380, 413
Wiring Devices 389-390

Z

Zinc Coated Sheets..... 275
Zinc Coated Strip..... 275

how Cash-Acme provides the Correct Answer to high back pressure valve maintenance costs


Closing cap (optional) prevents leakage in case of diaphragm failure; prevents unauthorized tampering.
Heavy, rugged body and spring chamber for pressure up to 400 psi in either iron or bronze. Also furnished in monel or stainless steel.
Carefully calibrated spring is the best obtainable; assures accurate opening and closing.
Diaphragm and seat disc securely fastened together; means positive and sensitive action.
New spherical seat disc promotes unusual sensitivity, exceptionally good closure and high capacity.
New "Floating-Ring" (patent applied for) assures perfect seat contact, tight closure.
For convenience in installation, valve may be either straight through (with bottom outlet) or angle type (with plug in one inlet).
Body seat screwed into body for ease in removal; valve may be trimmed in bronze, stainless steel, monel or nitralloy.

Here's How: When Cash-Acme's engineers designed the Type FR Back Pressure Relief Valves, they put *your* rising maintenance costs foremost in mind.. knowing that "down time" is extremely important. This superior valve series, therefore, is built to *exacting* specifications, featuring the nearest thing to *friction-free* operation as is possible to attain, which means less wearing of parts, longer life.

Do as other cost-conscious engineers and purchasing men are doing and switch to CASH-ACME.

A fact-jammed bulletin, with honest and accurate capacity charts, is available free of charge. Write today.

TYPE "FR"—Rugged Industrial Type Back Pressure Relief Valve, automatically maintains correct pressure on inlet, relieving to a lower pressure or to atmosphere. For 0 to 400 psi; ½" to 2" pipe sizes. Suitable for:

- AIR • WATER (Hot or Cold)
- GASOLINE
- OIL (Light or Heavy)
- FUEL TAR • AMMONIA
- FREON • BRINE • CO_2
- FISH OIL • NITROGEN
- HYDROGEN • ALCOHOL

Modified for:

- VACUUM RELIEF
- CONSTANT DIFFERENTIAL REGULATOR

FOR THE *Correct Answer*

CASH AUTOMATIC VALVES ACME

A. W. CASH VALVE MANUFACTURING CORP.

6662 East Wabash Avenue

Decatur, Illinois

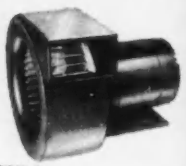
Performance through Precision

AIR MARINE MOTORS . . . leading manufacturers of high specification rotating equipment . . . is your outstanding source for fans, motors and blowers to meet most sub-fractional power requirements.

Adaptability through Variety

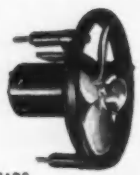
A15BD-8

115 Volt 60 cycle double blower. 46 CFM at .28" static pressure.



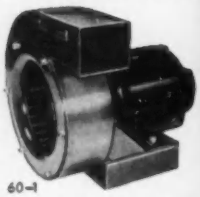
B20B-7

115 Volt 60 cycle (or 400 cycle) blower. 50 CFM at 1.5" static pressure.



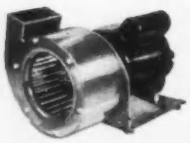
A15AD3

115 Volt 60 cycle axial blower. 35 CFM at .2" static pressure.



60-1

115 Volt 60 cycle blower. 100 CFM at 2.5" water gauge.

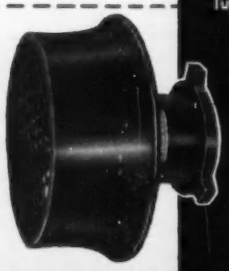


60-6

115 Volt (or 220 Volt) 60 cycle blower, 1 or 3 phase. 250 CFM at 2.5" water gauge.

years-ahead engineering . . .

Air Marine Motors equipment features stainless steel thru-bolts . . . die-cast aluminum housings . . . riveted stators . . . positive bearing alignment . . . uniform air gap . . . ball bearings . . . shock and vibration resistance . . . humidity and fungus resistance . . . omni-position mountings . . . temperature lubrication.



A11A-4 115 Volt 400 cycle single phase propeller type blower using 4" 4-blade fan. Delivers 250 CFM at 0" static pressure.

Write for specific information and brochure about any of these units . . . and use the Air Marine advisory services without obligation.

AIR MARINE MOTORS, INC.

air-marine motors, inc.

369 Bayview Avenue • Amityville, N. Y.

West Coast Factory: 2055 Pontius Avenue • Los Angeles 25, Calif.

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

A

Adams & Westlake Co. 216
Aeroquip Corp. 259
Airborne Accessories Corp. 421
Air-Marine Motors, Inc. 464
Alabama Wire Co., Inc. 402
Alemite 41
Allegheny Ludlum Steel Corp. 431
Allen-Bradley Co. 40
Allen Mfg. Co. 55
Allied Research Products, Inc. 378
Allied Wheel Products, Inc. 436
Allis-Chalmers Mfg. Co. 66, 70, 107
Allis Co., Louis 403
Aluminum Co. of America 247-250, 327
American Brass Co. 127
American Chain & Cable Co., Inc. 350
American Chemical Paint Co., Metal-working Chemical Div. 240
American Crucible Products Co. 406
American Cyanamid Co., Plastics & Resins Div. 319-321
American Felt Co. 383
American Gear & Mfg. Co. 368
American Lava Corp., Subs. of Minnesota Mining & Mfg. Co. 77
American Metal Hose Div., American Brass Co. 85
American Nickeloid Co. 244
American Plastics Corp., Subs. of Hayden Chemical Corp. 346
American Screw Co. 242
American Smelting & Refining Co. 265
American Steel & Wire Div., U. S. Steel Corp. 37, 112
Ampco Metal, Inc. 435
Apex Machine & Tool Co. 304
Armco Steel Corp. 10
Armstrong Cork Co. 57, 92, 114, 276
Arrow-Hart & Hegeman Electric Co. 389-390
Assembly Products, Inc. 450
Atlantic Screw Works, Inc. 242
Atlas Chain & Mfg. Co. 371
Automatic Electric Mfg. Co. 443
Automatic Switch Co. 315
Automotive & Aircraft Div., American Chain & Cable Co. 348
Automotive Gear Works, Inc. 1

B

Babcock & Wilcox Co., Tubular Products Div. 317
Bakelite Co., Union Carbide & Carbon Corp. 349
Baldwin - Lima - Hamilton Corp., Loewy-Hydropsin Div. 351
Bantam Bearings Div., Torrington Co. 72
Barksdale Valves 6
Bead Chain Co. 444
Beaver Precision Products, Inc. 393
Belden Mfg. Co. 415
Bellofram Corp. 404
Blake & Johnson Co. 242
Boston Gear Works 271
Bound Brook Oil-Less Bearing Co. 218
Bower Roller Bearing Div., Federal-Mogul-Bower Bearing, Inc. 124
Bridgeport Brass Co. 235
Bruning Co., Inc., Charles 283-286, 361, 375
Buffalo Bolt Co., Div., Buffalo-Eclipse Corp. 287
Bundy Tubing Co. 289
Bunting Brass & Bronze Co. 423

C

Cambridge Wire Cloth Co. 413
Cannon-Muskegon Corp. 268
Carboloy Dept., General Electric Co. 106
Carpenter Steel Co. 54
Cash Valve Mfg. Corp., A. W. 463
Central Foundry Div., General Motors Corp. 20-21
Central Screw Co. 242
Century Electric Co. 359
Cerro De Pasco Corp. 444

INDEX TO ADVERTISERS

Chain Belt Co. 355-356
Char-Lynn Co. 398
Chase Brass & Copper Co. 90
Chatillon & Sons, John 465
Chemical Products Corp. 436
Chicago Molded Products Corp. 130
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Chiksan Co. 245
Clark Controller Co. 370
Cleveland Worm & Gear Co. 73
Climax Molybdenum Co. 397
Clipper Belt Lacer Co. 395
Columbia-Geneva Steel Div., U. S. Steel Corp. 62-63, 112
Commercial Shearing & Stamping Co. 121
Cone-Drive Gears Div., Michigan Tool Co. 312
Continental Felt Co. 414
Continental Screw Co. 242
Corning Glass Works 407
Counter & Control Corp. 430
Cramer Co., Inc., R. W. 360
Crane Packing Co. 280
Crucible Steel Co. of America 329
Cullman Wheel Co. 334
Curtis Universal Joint Co., Inc. 316

D

Darling Valve & Mfg. Co. 409
Dayton Rogers Mfg. Co. 386
Dayton Rubber Co. 308-309
DeLaval Steam Turbine Co. 362
Delco Products Div., General Motors Corp. 11
Detroit Power Screwdriver Co. 387
Dexter & Sons, C. H. 363
Dial Products Co. 436
Diamond Mfg. Co. 450
Douglas Aircraft Co., Inc. 418
Dow Chemical Co. 24-25
Dow Corning Corp. 101-102
du Pont de Nemours & Co. (Inc.), E. I., Elastomers Div. 239
du Pont de Nemours & Co. (Inc.), E. I., Fabrics Div. 39
du Pont de Nemours & Co. (Inc.), E. I., Film Dept. 67
du Pont de Nemours & Co. (Inc.), E. I., Polychemicals Dept. 33-34
du Pont de Nemours & Co. (Inc.), E. I., Textile Fibers Dept. 104
Durakool, Inc. 346
Durametallic Corp. 396
Dynamatic Div., Eaton Mfg. Co. 326

E

Eagle Signal Corp., Industrial Div. 377
Eastman Kodak Co., Special Products Sales Div. 257
Eastman Mfg. Co. 263
Elastic Stop Nut Corp. of America 81
Elco Tool & Screw Corp. 242, 352
Electro Dynamics Div., General Dynamics Corp. 323
Electro Switch Corp. 419
Enjay Co., Inc. 339

F

Fafnir Bearing Co. 225
Fairbanks, Morse & Co., Magneto Div. 297
Farrel-Birmingham Co., Inc. 267
Fasteners, Inc. 260
Faultless Caster Corp. 363
Federal Bearings Co., Inc. 358
Federal Die Casting Co. 334
Federal Mogul Div., Federal-Mogul-Bower Bearings, Inc. 273
Federated Metals Div., American Smelting & Refining Co. 296
Fellows Gear Shaper Co. 337
Fenwal, Inc. 35
Ferguson Machine & Tool Co. 417
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 366
Ford Motor Co., Industrial Engine Dept. 220
Foote Bros. Gear & Machine Corp. 93
Foote Gear Works, Inc., Brad 368
Formica Corp. 84
Frenchtown Porcelain Co. 333
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. 261

(Continued on Pg. 466)

CHATILLON
TORSION SPRINGS
for
HIGHEST FATIGUE LIFE

AVAILABLE IN PRACTICALLY ALL SIZES AND CAPACITIES

"Vitality" is an important characteristic of Chatillon Torsion Springs, insuring continuous, fool-proof actuation of critical instrument components such as shutter devices, rotors, etc.

For this reason—and because Chatillon Torsion Springs are accurately calibrated to meet the strictest torque requirements—leading instrument manufacturers specify Chatillon Torsion Springs in their designs. Manufacturers include Fairchild Camera and Instrument Corp., Sperry Gyroscope Co., Bulova Research & Development Corp., and many others.

Chatillon makes Torsion Springs in all the conventional alloys as well as in Chatillon's unique temperature-compensated material Iso-Elastic* (virtually unaffected by temperatures from −50°F. to +150°F.)

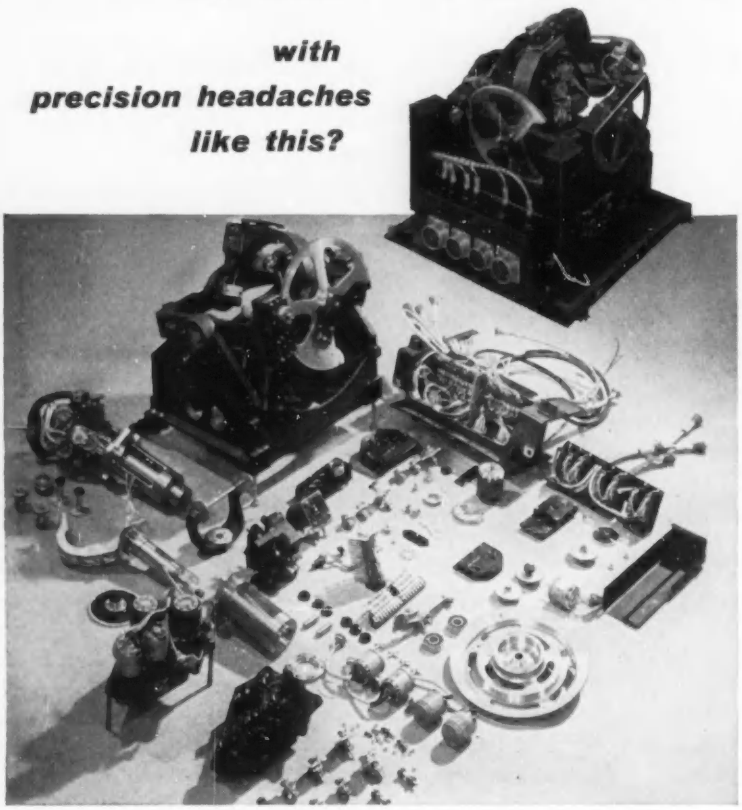
Call on Chatillon's Spring Division for their experienced assistance with your designs. Write for engineering bulletins.

*U.S.A. Pat. No. 2174171

JOHN CHATILLON & SONS
85 Cliff Street, New York, N. Y.
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

Can you use help

with precision headaches like this?



Let General Mills work them out for you

Right now our systems engineering people and our factory can be at your service if you need volume piece parts or assemblies such as

- electro-mechanical systems or components
- fine-pitch, instrument-type gears
- precision parts, cutting, grinding, finishing
- industrial or military optical assemblies

Right now you can utilize the experience of our creative engineers and precision production plant—the same men and machines that have handled prime and sub-contract work like the bombing system computer above, the B-47's Y-4 bombsight, and similar complex systems. And of course we offer full laboratory and environmental testing facilities.

LET US BID on your specific requirements today. Save time, cut costs and eliminate the worrisome problems you face in recruiting competent engineers and skilled production hands. We have them now . . . and can rush delivery of parts or whole packages *in quantity, on time, to meet strict military specs.*

***ASK FOR FREE NEW BOOKLET** covering complete manufacturing capacities and capabilities. Write, wire, or phone Dept. PE6, 1620 Central Ave., Minneapolis 13, Minn., STerling 9-8811.*

MECHANICAL DIVISION

OF General Mills, Inc.

INDEX TO ADVERTISERS

(Continued from Pg. 465)

G

Garrett Co., Inc., George K. 342
Gast Mfg. Corp. 330
Gates Rubber Co. 278
General Dynamics Corp., Electro Dynamics Div. 323
General Electric Co., Apparatus Dept. .....67 A & B, 89, 100, 122-123
General Electric Co., Construction Materials Div. 110-111
General Electric Co., Silicone Products Dept. 75
General Industries Co. 292
General Mills, Inc., Mechanical Div. ... 466
General Plate Div., Metals & Controls Corp. 31
Genisco, Inc. 372
Gering Products, Inc., Custom Extrusions Div. 318
Gerotor May Corp. 310-311
Gits Bros. Mfg. Co. 293
Goodrich Co., B. F. 97
Grant Pulley & Hardware Corp. 76
Great Lakes Screw Corp. 242
Great Lakes Steel Corp., Div., National Steel Corp. 231
Greene, Tweed & Co. 386
Guardian Products Corp., Coupling Div. 432

H

Hagen Mfg. Co., Inc., Subs. of Eagle Signal Corp. 241
Hannifin Corp. 277
Harper Co., H. M. 242, 288
Harrison Radiator Div., General Motors Corp. 65
Hart Mfg. Co. 357
Haydon Mfg. Co., Inc. 264
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 64
Heim Co. 36
Heinze Electric Co. 420
Helicoid Gage Div., American Chain & Cable Co., Inc. 350
Heli-Coil Corp. 433
Heyman Mfg. Co. 408
Hommel Co., O. 430
Houghton & Co., E. F. 94
Houghton Laboratories, Inc. 401
Howard Industries, Inc. 374

I

I-T-E Circuit Breaker Co., Transformer & Rectifiers Div. 120
Illinois Gear & Machine Co. 229
Imperial Tracing Cloth 408
Indiana Steel Products Co. 451
Industrial Timer Corp. 116
Instrument Specialties Co., Inc. 425
International Business Machines Corp. 460
International Nickel Co., Inc. 14

J

Jahn Mfg. Co., B. 282
Johns-Manville Corp. 336
Johnson Machine Co., Carlyle 325
Jones & Laughlin Steel Corp. 109

K

Kaiser Aluminum & Chemical Corp. 343-345
Kaydon Engineering Corp. 237
Keuffel & Esser Co. 458
Keystone Carbon Co. 71
Kilian Mfg. Corp. 416
Koppers Co., Inc., Chemical Div. 87
Koven & Bro., Inc., L. O. 373
Kraissl Co., Inc. 327

L

Laminated Shim Co., Inc. 353
Lamson & Sessions Co. 242, 341
La Salle Steel Co. 128
Leiman Brothers, Inc. 394
Leland Electric Co., Div., The American Machine & Foundry Co. ... 266
Leland, Inc., G. H. 434
Lewellen Mfg. Co. 126
Licon Div., Illinois Tool Works 332

INDEX TO ADVERTISERS

Lincoln Electric Co. 364
Linear, Inc. 424
Link-Belt Co. 13, 15, 59
Lockheed Aircraft Corp. 422
Lord Mfg. Co. 243
Lukens Steel Co. 46

M

McGill Mfg. Co., Inc. 233
McLouth Steel Corp. 376
MB Mfg. Co., Inc. 328
MacLean-Fogg Lock Nut Co. 448
Magnesium Co. of America 428
Makepeace Co., D. E., Div., Union Plate & Wire Co. 394
Malleable Founders' Society 399
Mallory & Co., Inc., P. R. 4
Marathon Electric Mfg. Corp. 253
Marble-Card Electric Co. 396
Marlin-Rockwell Corp. 298
Marquette Metal Products Co., Subs. of Curtiss-Wright Corp. 445
Marvel Engineering Co. 467
Master Electric Co. ..... 3rd Cover
Merkle-Korff Gear Co. 83
Metallizing Engrg. Co., Inc. 254-255
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Metal & Thermit Corp. 392
Meyercord Co., Name Plate Div. 416
Mica Insulator Co., Subs. of Minnesota Mining & Mfg. Co. 331
Michigan Tool Co., Cone-Drive Gears Div. 312
Micromatic Hone Corp. 274
Midland Steel Products Co. 446
Miehle-Dexter Supercharger Div., Dexter Folder Co. 364
Milford Rivet & Machine Co., The 303
Miller Co. 410
Miller Fluid Power Div., Flick-Reedy Corp. 61
Minneapolis Honeywell Regulator Co., Industrial Div. 301
Minnesota Mining & Mfg. Co. 74
Monsanto Chemical Co. 18-19
Monsanto Chemical Co., Organic Div. 335
Morganite, Inc. 440
Morse Chain Co. 347
Mt. Vernon Die Casting Corp. 411
Mutual Electronics Industries, Inc. 401

N

National Cash Register Co. 400
National Lock Co. 242
National Machine Products Co. 428
National Motor Bearing Co., Inc. 78
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 354
National Screw & Mfg. Co. 108, 242
National-Standard Co. 95
National Steel Corp. 231
National Tube Div., U. S. Steel Corp. 58, 112
National Vulcanized Fibre Co. 470
Nelson Stud Welding 452
Newark Wire Cloth Co. 380
New Departure Div., General Motors Corp. 134
New England Mica Co., Inc. 354
New Hamphire Ball Bearings, Inc. 379
New Hermes Engraving Machine Corp. 385
Ney Co., J. M. 372
Nicholson & Co., W. H. 270
Norgren Co., C. A. 290-291

O

Ohio Gear Co. 462
Ohio Nut & Bolt Co. 424
Onan & Sons, Inc., D. W. 449

P

Packard Electric Div., General Motors Corp. 38
Paramount Die Casting Co. 421
Parker Appliance Co. 391
Parker-Kalon Div., General American Transportation Corp. 60, 242

(Continued on Pg. 468)

MARVEL *Synclinal* FILTERS

Answer DESIGNERS S.O.S.

For Dependable Protection on All Hydraulic and Low Pressure Systems

Simple, Balanced Design . . . is the answer to the growing preference for MARVEL Synclinal FILTERS. Designers are specifying Marvel Synclinal Filters to assure minimum maintenance and maximum protection. Results show Marvel Synclinal Filter superiority in maintaining the greatest degree of cleanliness of liquids in all hydraulic and low pressure systems with minimum downtime. Furthermore, when filter servicing is necessary, Marvels can be easily disassembled, cleaned and reassembled by any workman in a matter of minutes. Line types operate in any position and may be serviced without disturbing pipe connections.

Again and again, Marvel Synclinal Filters have demonstrated they meet all requirements of the most exacting users, that today—OVER 650 ORIGINAL EQUIPMENT MANUFACTURERS install Marvel Synclinal Filters as standard equipment!

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 GPM. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

IMMEDIATE DELIVERY

As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

Catalogs containing complete data available on request

MARVEL ENGINEERING COMPANY
7227 N. Hamlin Ave., Chicago 45, Ill.
Phone: JUNIPER 8-6023

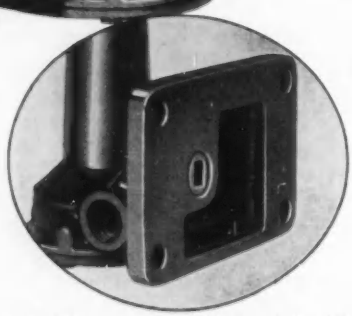
PE-6

Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated:—

☐ Catalog No. 107—For Hydraulic Oils, Coolants and Lubricants
☐ Catalog No. 301—For WATER
☐ Catalog No. 200—For Fire-resistant hydraulic fluids

Name .....
Title .....
Company .....
Address .....
City .....
State .....

This New PIONEER Coolant Pump gives you Important Advantages



1. Totally enclosed motor, with extra-heavy shaft and heavy-duty ball bearings.
2. Handles abrasives or chips without injury to the pump.
3. Will pump down to 1 1/16"; self-priming to 1" liquid level.
4. Permits clean-out of machine sump with minimum time and labor.
5. Interchangeable with any make pump with standard mounting dimensions.
6. Sealless design with no metal-to-metal moving parts.
7. Can be furnished with any desired electrical characteristics.
8. Three optional outlets: left external, right external, center outlet through mounting flange. The latter permits compact, clean-cut design of machine with no exposed piping.

Pioneer offers more than 400 models of impeller-type and positive displacement pumps to meet every coolant pump requirement; or we will develop designs for specific applications. Our application engineers will welcome the opportunity to discuss your pump requirements with you.

Send for our illustrated booklet covering the basic Pioneer designs in both impeller-type and positive displacement pumps.

PIONEER PUMP DIVISION
DETROIT HARVESTER COMPANY
Sales Office: 5450 West Jefferson Ave., Detroit 9, Michigan
Plant: Paris, Kentucky

INDEX TO ADVERTISERS

Continued from p. 467

Parker Rust Proof Co. 8
Parker Stamp Works, Inc. 457
Parker White Metal Co. 262
Pathon Mfg. Co. 44
Peerless Electric Co., Fan & Blower Div. 444
Peerless Electric Co., Motor Div. 398
Penn Metal Co., Inc. 340
Perfection Gear Co., American Stock Gear Div. 384
Perkins Machine & Gear Co. 251
Petch Mfg. Co. 416
Phalo Plastics Corp. 448
Pheoll Mfg. Co. 242
Pioneer Pump Div. of Detroit Harvester Co. 468
Polymer Corp. of Pennsylvania 306
Porcelain Enamel Institute, Inc. 125
Portable Electric Tools, Inc., Special Products Div. 103
Pratt & Whitney 447
Price Corp., D. W. 410
Process Gear Co., Inc. 357
Product Engineering 118-119
Production Instrument Co. 406
Progressive Mfg. Co., Div. of The Torrington Co. 404
Pure Carbon Co., Inc. 279
Purolator Products, Inc. 429

R

Rawson Coupling Div., O. S. Walker, Inc. 405
Reeves Div., Reliance Electric & Engrg. Co. 26-27
Reeves Instrument Corp., Subs. Dynamatic Corp. of America 420
Republic Steel Corp. 28-29
Reslabs, Inc., Div. of Linco Products Corp. 432
Revere Copper & Brass, Inc. 2, 79
Revere Corp. of America, Subs. of Neptune Meter Co. 459
Richardson Co. 369
Rivett Lathe & Grinder, Inc. 269
Robbins & Myers, Inc. 22-23
Rockford Clutch Div., Borg-Warner Corp. 412
Rockwood Sprinkler Co., Ball Valve Div. 313
Roll Formed Products Co. 86
Roth Rubber Co. 305
Russell, Burdsall & Ward Bolt & Nut Co. 324
Ruthman Machinery Co. 388

S

SKF Industries, Inc. 322
Saginaw Steering Gear Div., General Motors Corp. 47
Schrader's Son, A., Div. Scovill Mfg. Co. 88
Sciaky Bros., Inc. 442
Scovill Mfg. Co. 242
Screw Research Association 242
Shakeproof Div. of Illinois Tool Works 242, 295
Sharon Steel Corp. 275
Silicones Div., Union Carbide & Carbon Corp. 96
Simmons Fastener Corp. 56
Sinko Mfg. & Tool Co. 428
Skinner Electric Valve Div., Skinner Chuck Co. 381
Smith Corp., A. O., Electric Motor Div. 52-53
South Chester Corp., Southco Div. 51
Southington Hardware Mfg. Co. 242
Sparta Mfg. Co. 412
Speer Carbon Co. 450
Spencer Thermostat Div., Metals & Controls Corp. 30
Stackpole Carbon Co. 314
Standard Pressed Steel Co. 12, 68
Stephens-Adamson Mfg. Co., Sealmaster Bearings Div. 105
Sterling Bolt Co. 242
Stewart Corp., F. W. 430
Stewart Warner Corp. (Alemite) 41
Strataflo Products, Inc. 414
Stromberg-Carlson Div., General Dynamics Corp. 426
Sturtevant Co., P. A. 410
Superior Carbon Products, Inc. 272
Sutton Corp., Inc., O. A. 427
Sylvania Electric Products, Inc., Parts Div. 299
Syncro-Start Products, Inc. 394
Synthane Corp. 252

INDEX TO ADVERTISERS

T

Taylor Fibre Co. 385
Tennessee Coal & Iron Div.,
U. S. Steel Corp. 62-63, 112
Thermoid Co. 300
Thiokol Chemical Corp. 113
Timken-Detroit Brake Co.,
Rockwell Spring & Axle Co. 294
Timken Roller Bearing Co. 69
Tinnerman Products, Inc. 132
Tomkins-Johnson Co. 302
Torrington Co.,
Bantam Bearings Div. 72
Trombetta Solenoid Corp. 386
Tuthill Pump Co. 461
Twin Disc Clutch Co. 246
Tyer Rubber Co. 352

U

Union Carbide & Carbon Co.,
Bakelite Co. 349
Haynes Stellite Co. 64
Silicones Div. 96
U. S. Electrical Motors, Inc. 91
U. S. Graphite Co., Div. of the
Wickes Corp. ..... 4th Cover, 48-49
U. S. Rubber Co., Footwear Div. 82
U. S. Rubber Co.,
Mechanical Goods Div. 50
U. S. Steel Corp. 62-63, 112
U. S. Steel Export Co. 62-63, 112
U. S. Steel Supply Div.,
U. S. Steel Corp. 62-63, 112
United Wire & Supply Corp. 438
Universal Drafting Machine Corp. 338
Universal Oil Seal Co. 384
Universal Screw Co. 242

V

Veeder-Root, Inc. 17
Vellumoid Co. 398
Vickers, Inc., Div. of
Sperry-Rand Corp. 117
Viking Pump Co. 405
Vlier Engrg. Co. 441

W

WacLine, Inc. 414
Wagner Electric Corp. 382, 404
Waldes-Kohinoor, Inc. 45
Waldron Corp., John 256
Wales-Beech Corp. 242
Wales Strippit Corp. 420
Washington Steel Corp. 258
Waukesha Foundry Co. 16
Weirton Steel Co., Div.,
National Steel Corp. 307
Weldon Tool Co. 437
Westinghouse Electric Corp.
32, 42-43, 80, 115, 439, 469
White Dental Mfg. Co., S. S. 227
Wilcolator Co. 367
Winzeler Mfg. & Tool Co. 281
World Bestos Div., Firestone
Tire & Rubber Co. 426
Worthington Corp. 98-99

Z

Zenith Carburetor Div.,
Bendix Aviation Corp. 408

•

PROFESSIONAL SERVICES 456

Classified Advertising

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 453-456

SPECIAL SERVICES 456

Index to Advertisers begins on P 464

Products Index begins on P 457

VITAL PROJECTS such as AERO-13 CHALLENGE YOU at Westinghouse BALTIMORE DIVISIONS

In the nose of the Douglas F4D Skyray fighter interceptor is the new Aero-13 Fire Control System developed by Electronics Engineers at Westinghouse—Baltimore Divisions. This improved system makes possible the detection and destruction of enemy aircraft under no-visibility weather conditions. (Photo courtesy Douglas Aircraft Company, Inc.)

The development of this System is but one of a series of challenging projects in airborne, ground and shipboard electronic systems that offer the electronics engineer the true growth potential so important for a real future. Your career at the Westinghouse Baltimore Divisions will be one of unlimited opportunities—including opportunities for work on advanced projects, and opportunities to continue your education toward advanced degrees at the company's expense. If you are interested in this type of career, Westinghouse is interested in you!

ADVANCED EDUCATION AT COMPANY EXPENSE

Westinghouse encourages its electronics engineers to continue their education toward both M.S. and Ph.D. degrees. The company pays all tuition expenses.

Current Openings EXIST IN THE FIELDS OF:

CIRCUITRY
MICROWAVES
SERVOMECHANISMS
MAGNETIC AMPLIFIERS
DIGITAL COMPUTER PROGRAMMING
FIRE CONTROL SYSTEMS
OPTICS
PACKAGING
TRANSFORMERS
ANALOG COMPUTER DESIGN
TECHNICAL WRITING
VIBRATION
RADAR DESIGN
FIELD SERVICE
INFRARED TECHNIQUES
COMMUNICATIONS
ANTENNAS

TO APPLY

Send resume of education and experience to:
Technical Director, Dept. 328
Westinghouse Electric Corp.
Friendship Airport
Baltimore, Maryland

WATCH Westinghouse

Where big things are happening every day!

THE LATEST NEWS ON POSTFORMED PHENOLITE®

Manufacturers slash assembly time, eliminate rejects, improve products with PHENOLITE parts postformed by NATIONAL

Production speeded, unit costs reduced—from plant after plant comes news of big profits and savings through the use of PHENOLITE parts postformed by National.

Reasons for their cost-cutting efficiency are: (1) National makes PHENOLITE in *many* grades with combinations of service properties unmatched in any other type of material, and (2) National's applications engineers and fabricators are experts at adapting PHENOLITE to specific requirements. We can help you all the way from development of a material—through design—to the delivery of fully fabricated parts.

Want to simplify design and speed production? It will pay you—in reduced unit costs or in product improvement at no added cost—to explore the advantages of special, ready-to-use PHENOLITE parts postformed by National. Send us the problem that's nagging you—and be sure to ask for our new 16-page Catalog on PHENOLITE and other National products. We'll send it promptly, without obligation. Simply write Dept. H-6.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

VULCANIZED FIBRE • PHENOLITE LAMINATED PLASTIC • NATIONAL NYLON
PEERLESS INSULATION • KENNETT MATERIALS HANDLING RECEPTACLES • VUL-COT
WASTEBASKETS • LESTERSHIRE TEXTILE BOBBINS • VULCOT PRODUCTS FOR THE HOME

R. F. Bogart, one of National's staff of applications engineers, shown holding a postformed copper clad PHENOLITE printed circuit.

Reverse bends and small radii—toughest problems in forming—were involved in shaping this spring-action, snap-on cover for a switch voltage changer. National's postforming technicians used PHENOLITE C-534-F to achieve a 1/16" radius bend.

Corrugated, bent, and punched after forming, this insulator had to be made of extraordinary stock to withstand unusual stresses. National made use of a double die and PHENOLITE C-534-F to form the corrugated component without cracking or fracturing the piece.

Bending and drawing in one operation were difficulties faced in forming this bus bar joint cover. National ended the trouble by using PHENOLITE X-114-A. PHENOLITE can be formed or deep drawn easily—without damage to the material and without expensive dies.

NEW 3-POINT EASY-TO-USE

READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalog and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key numbers in the space indicated. Bulletins are described on pages 316-338

To get more data about new Components, Materials and Parts fully described on pages 222-314, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top left; BL—Bottom left; TR—Top right; BR—Bottom right.

For specialized data — prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space allotted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name

Position

Company

Address

City & State

NEW PRODUCTS... Description of these new engineering materials appear on pages 222-314. Circle key number for more data

1—Brake for Fluid Coupling Motor
2—Printed Circuit Tape
3—Ball-Bearing Remote Control
4—Airfoil Shaped Strip
5—Decorative Cast Acrylic Sheet
6—Step-Function Speed Reductor
7—Multiple Color Spray Enamel
8—High-Strength PVC Pipe
9—Rectangular Meter
10—Rotary Segmented Switches
11—High-Speed Relay
12—Motors With Extruded Insulation
13—Four-Way Selector Valve
14—Subminiature Potentiometer
15—Sub-Miniature Resistor
16—Miniature D-c Motor
17—Waterproof Footswitch
18—Waterproof Snap Switch
19—Transistor Servo Amplifier
20—Spherical Corners
21—Constant Displacement Air Motor
22—Anti-Seize and Sealing Material
23—Automatic Temperature Control
24—Light Duty Foot Switch
25—Filters and Regulates Air
26—Potentiometer
27—Gear Head for Size 8 Motors
28—Non-Adjustable Thermostat
29—Oil Tight Electrical Wiring Box
30—Removable Thermostats
31—Miniature D-c Motors
32—Miniature Power Resistor
33—Printed Circuit Grid Paper
34—Remote Thermostat Socket
35—Sintered Iron-Bronze Bearings
36—In-Line Water Filter
37—Motor-Mounted Centrifugal Pump
38—Flexible Gear Coupling
39—Spline-Coupled Pump Motor
40—Miniature Thermocouple Head
41—External Wrenching Nut
42—Oscilloscope for 100x
43—Valves Protected from Load Drop
44—Vitreous-Enameled Resistors
45—Maximum-Minimum Thermometer
46—Hydraulic Motor Valve
47—Self-Hardening Plastic-Metal
48—Selector Valve for 1000 psi
49—Electrical Tubing
50—Time-Governed D-c Motors
51—Footswitch Housed in Aluminum
52—Gear Motor for High Shock
53—Absolute Pressure Transmitter
54—A-c Motor Tachometer
55—Valve for Air-Operated Clutches
56—Vibration Calibrator
57—Appliance Thermostat
58—Venting Traps
59—Solenoid Directional Valves

PRINT or TYPE your address before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	15	16	17	18-9
20-1	22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39
40	41	42-3	44	45	46	47	48-9	50	51	52-3	54	55	56
57	58	50	60	61	62-3	64	65	66	67	67a-b	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98-9
100	101-2	103	104	105	106	107	108	109	110-1	112	113	114	115
116	117	120	121	122-3	124	125	126	127	128	130	132	134	216
218	220	225	227	229	231	233	235	237	239	240	241	242	243
244	245	246	247-50	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283-6	287	288	289	290	291
292	293	294	295	296	297	298	299	300	301	302	303	304	305
306	307	308-9	310	311	312	313	314	315	316	317	318	319-21	322
323	324	325	326	L327	R327	328	329	330	331	332	333	T334	B334
335	336	337	338	339	340	341	342	343-4	345	T346	B346	347	348
349	350	351	L352	R352	353	L354	R354	355-6	T357	B357	358	359	360
361	363	L364	R364	365	366	367	368	369	370	371	T372	B372	373
374	375	376	377	378	379	380	381	382	383	L384	R384	385	L386
TR386	BR386	387	T388	B388	389-90	391	392	L393	R393	L394	TR394	BR394	395
T396	B396	397	L398	TR398	BR398	399	L401	R401	402	403	L404	TR404	BR404
T405	B405	L406	R406	407	L408	TR408	BR408	409	TL410	BL410	R410	411	L412
R412	413	L414	TR414	BR414	415	T416	BL416	BR416	417	419	L420	TR420	BR420
L421	R421	423	L424	R424	425	L426	R426	427	L428	TR428	BR428	429	L430
TR430	BR430	431	L432	R432	433	434	435	L436	TR436	BR436	437	438	439
440	441	442	443	L444	TR444	BR444	445	446	L448	TR448	449	L450	TR450
BR450	451	452	457	458	459	461	462	463	464	465	466	467	468
470	C3	C4											

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93					

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

94	95	96	97	98	99	100	101	102	103	104	105	106	107
108	109	110	111	112	113	114	115	116	117	118	119	120	121
122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147		

Card expires August 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF .....

USE THIS SPACE TO INDICATE REQUIRED.....

60—Combination Strainer Traps
61—Plug-In Control Systems
62—Bead Belt Drive
63—Malfunction Dector
64—Power Transducer
65—Printed Circuit Capacitors
66—High Temp Lubricating System
67—Shock-Measuring Instrument
68—Hysteresis Synchronous Motor
69—General Purpose Time Switch
70—Anchor Nuts for High Temepratures
71—Transformer For 24 V Circuits
72—Fluorothene Sheets For Bonding
73—Pneumatic Drafting Template
74—Sub-Fhp Straight Motors
75—Variable Scale Counter
76—Table Model Whiteprinters
77—Measures, Analyses Noise
78—Tracing Vellum
79—Recycling Electronic Timer
80—Hermetic Power Transformers
81—Synchronized Multiple Drive
82—Automatic Drive For Small Engines
83—Analog-to-Digital Converter
84—Hermetic Plate Transformers
85—Insulating Washers
86—Volt-Ohm-Milliammeter
87—Subminiature Relay
88—Intervalometer
89—Calculating Instrument
90—Miniature Pressure Transducer
91—Single and Two-Circuit Switches
92—Voltmeter
93—Adjustable Power Supply

PRODUCTS ADVERTISED

NEW PRODUCTS . . .

NEW BULLETINS . . .

SPECIFIC DATA . . .

NEW BULLETINS . . . listed below are described on pages 316-338. Circle key number for your copy.

94—Adhesives, Coatings, Sealers
95—Hydraulic Clyinder Mountings
96—Speed Control Valves
97—Thumb Nuts and Screws
98—Fastenings
99—Metalworking
100—Die Casting Alloys
101—O-Rings
102—Electro-Mechanical Kits
103—Panel Meters
104—Vibration Mountings
105—Heavy Duty Clutches
106—Packings
107—Miniature Gear Train
108—Semi-Pneumatic Wheels
109—Automatic Transfer Switches
110—Wound Cores
111—Precision Components
112—Springs
113—Hydraulic Cylinders and Valves
114—Metal Alloys
115—Piloted-Operated Valves
116—Power Solenoids
117—Manual Motor Starters
118—D-c Amplifiers
119—One-Shot Lubricators
120—Capacitors
121—Beryllium Copper Components
122—Plastic Structural Materials
123—Reading Glasses and Magnifiers
124—Automatic Temperature Control
125—Roller Bearings
126—Ball Bearings
127—Wire Rope
128—Power Supplies
129—Glass Pipe and Fittings

PRINT or TYPE your address before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	15	16	17	18-9
20-1	22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39
40	41	42-3	44	45	46	47	48-9	50	51	52-3	54	55	56
57	58	59	60	61	62-3	64	65	66	67	67a-b	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98-9
100	101-2	103	104	105	106	107	108	109	110-1	112	113	114	115
116	117	120	121	122-3	124	125	126	127	128	130	132	134	216
218	220	225	227	229	231	233	235	237	239	240	241	242	243
244	245	246	247-50	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283-6	287	288	289	290	291
292	293	294	295	296	297	298	299	300	301	302	303	304	305
306	307	308-9	310	311	312	313	314	315	316	317	318	319-21	322
323	324	325	326	L327	R327	328	329	330	331	332	333	T334	B334
335	336	337	338	339	340	341	342	343-4	345	T346	B346	347	348
349	350	351	L352	R352	353	L354	R354	355-6	T357	B357	358	359	360
361	363	L364	R364	365	366	367	368	369	370	371	T372	B372	373
374	375	376	377	378	379	380	381	382	383	L384	R384	385	L386
TR386	BR386	387	T388	B388	389-90	391	392	L393	R393	L394	TR394	BR394	395
T396	B396	397	L398	TR398	BR398	399	L401	R401	402	403	L404	TR404	BR404
T405	B405	L406	R406	407	L408	TR408	BR408	409	TL410	BL410	R410	411	L412
R412	413	L414	TR414	BR414	415	T416	BL416	BR416	417	419	L420	TR420	BR420
L421	R421	423	L424	R424	425	L426	R426	427	L428	TR428	BR428	429	L430
TR430	BR430	431	L432	R432	433	434	435	L436	TR436	BR436	437	438	439
440	441	442	443	L444	TR441	BR441	445	446	L448	TR448	449	L450	TR450
BR450	451	452	457	458	459	461	462	463	464	465	466	467	468
470	C3	C4											

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93					

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

94	95	96	97	98	99	100	101	102	103	104	105	106	107
108	109	110	111	112	113	114	115	116	117	118	119	120	121
122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147		

Card expires August 1

130—Chromium Stainless
131—Colloidal Dispersions
132—Pneumatic Disconnect
133—Liquid Springs
134—Pipe and Tubing
135—Fhp Motors
136—Cold-Extruded Fastenings
137—Small-Mesh Expanded Metal
138—D-c Motors
139—Rotary Switches
140—Magnetic Materials
141—Magnetic Alloys
142—Tungsten and Molybdenum
143—Standard Plastic Parts
144—Metallized Ceramic Coating
145—Stampings in Small Lots
146—Power Take-Off Gears
147—Pumps

USE THIS SERVICE

....to get your copies of new catalogs and bulletins

....for information on New Products listed in this issue

....for more information about products advertised in this issue

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name

Position

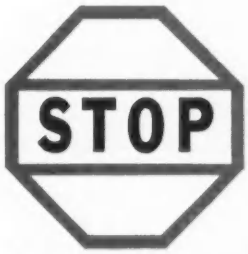
Company

Address

City & State

6-56

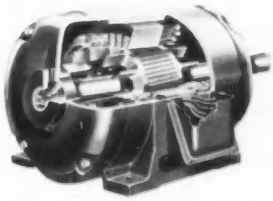
Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.



TWO WAYS...with Master Unibrakes

STOP-HOLD—Master Type M Magnetic Unibrake Motors. For quick, controlled stopping—especially when you want to hold the load. Spring-setting magnetic release brakes of the friction disc type combine with motor in a compact, integral unit. Sizes—⅛ to 150 H.P.

ROLLING STOP—Master Type D Dynamic Unibrake Motors. Braking is obtained with a unique, patented brake winding superimposed on the stator winding. Simple, compact, with no DC current required, the brake has no moving parts. There is nothing to wear or adjust—braking torque repeats consistently. Particularly recommended for automatic applications which do not require static holding. Sizes up to 30 H.P.



MASTER GEARMOTORS and variable speed drives can be supplied with integrated Unibrakes too. See Master for the perfect power drive for you.

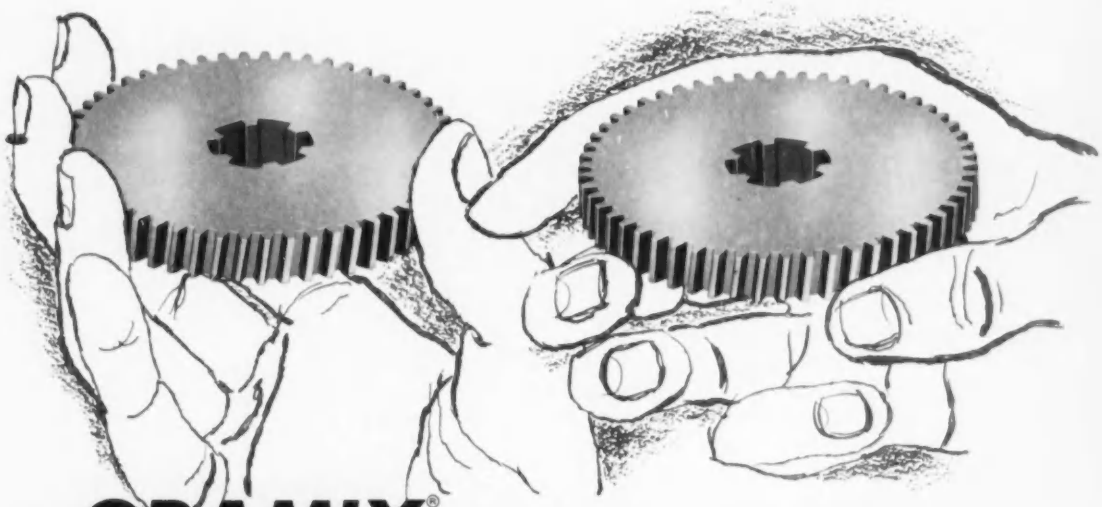
Type M Unibrake

MASTER

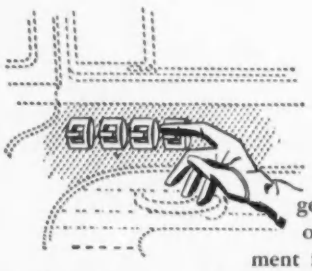
THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

UNIBRAKE MOTORS

which helical gear costs 80% less?



the GRAMIX® sintered metal helical gear performs better than a forged and hobbed aluminum part for just 1/5 the cost!



By replacing forged aluminum gears with sintered steel GRAMIX helical gears, a manufacturer of automotive equipment found that he could realize an 80% saving and get greater dependability. The gear is a component of an automatic window raising and lowering mechanism currently being used by four different automobile manufacturers. The helical teeth are formed in the compacting dies, and, after sintering, the GRAMIX gear is ready for assembly into the power window unit . . . there is no need for costly machining or time-consuming finishing operations like the hobbed aluminum gear used previously. In spite of the astonishing savings, these GRAMIX gears have proven to be even better than the former forged gear from a standpoint of toughness and wearability.

GRAMIX metallurgists can provide the exact alloy for your design specifications. GRAMIX parts may be oil-impregnated for self-lubrication. They seldom need machining, and will often outlast similar machined parts. Complex shapes can be produced to tolerances as close as .0005". Whatever your requirements may be, it will pay you to investigate GRAMIX.

Do you have our big detailed GRAMIX catalog? . . . write today for your copy.

114

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN